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ENVIRONMENTAL ASSESSMENT OF GRIP:

FINAL REPORT

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EXECUTIVE SUMMARY

In May, 1992, Agriculture Canada contracted with Environmental Management Associates (EMA) to conduct an environmental assessment of the Gross Revenue Insurance Program (GRIP) and the Net Income Stabilization Account (NISA), as required under the 1991 Farm Income Protection Act (FIPA). The assessment of GRIP is provided in two documents, Volume I: Final Report and Volume II: Technical Papers. The documents include a general review of primary environmental issues in Canadian agriculture and specific issues relating to GRIP, a description of how the assessment was conducted, and what the study concluded.

Primary Assessment Issues

"National" environmental issues facing Canadian agriculture were identified largely based upon information from the **Report to Ministers of Agriculture by the Federal-Provincial Agriculture Committee on Environmental Sustainability** (June 30, 1990). Included were concerns over soil degradation, surface and groundwater quality, destruction of wildlife habitats by agricultural activities, air quality and climate issues such as global warming. These "national" issues helped to establish the general context for both the "provincial/regional" issues and several specific assessment issues for the GRIP environmental review. The emphasis on concerns varied among provinces but the themes of soil degradation, wildlife habitat losses and water quality were common to most provinces.

Specific environmental issues associated with GRIP included the environmental implications of potential distortions in land use, crop selection, chemical use and cultivation practices. Among the possible impacts associated with GRIP, the most attention was focused on soil erosion, water quality and wildlife habitat, including wetlands.

How Was the Review Conducted?

The assessment included four basic elements to address the identified GRIP-related environmental issues. The first involved a theoretical analysis of how GRIP functioned in each province. Secondly, a descriptive assessment was based on a mail survey of almost 10,000 farmers across Canada; the overall response rate of 64% was considered excellent, with Provincial rates ranging from 58% in Saskatchewan to 74% in Ontario. Additionally, structured interviews with resource professionals were held across Canada to solicit opinions on GRIP and further contributions were obtained through written submissions from the public and interested organizations. Thirdly, statistical analyses of secondary data such as Canada Census and Crop Insurance were performed, including the use of econometric models. The last element was the use of the Erosion Productivity Impact Calculator (EPIC) to evaluate soil erosion and water quality concerns.

What Did the Study Conclude?

The scope of this environmental assessment was confined to the period immediately preceding the introduction of GRIP and the first two years of GRIP's operation. It was intended to measure the incremental change in environmental performance because of GRIP. It was not an evaluation of the implications of farm support systems versus no farm support systems. This was the case as Canada has a long-standing history of farm support systems such as crop insurance, WGSA and various ad hoc programs dating back over 30 years.

It should also be emphasized that market influences likely have a greater influence on farmer behaviour regarding crop selection and land use activities than a program such as GRIP. Evidence of this is present from the 1970's when high grain prices led to widespread and large-scale conversion of marginal lands and wetlands in order to bring more land into production. Indeed, it was the environmental consequences of that period that led directly to heightened awareness to the importance of soil conservation and wetland protection. This is not to downplay the identified impacts of GRIP but rather, to point out that the market may play a more dominant role in dictating environmental impacts than those identified in this study.

DOES GRIP CONTAIN THE POTENTIAL FOR MORAL HAZARD?

Moral hazard (abuse of GRIP by participating farmers), may involve the failure to use appropriate amounts of production inputs such as fertilizers and pesticides. While there may be short-term economic benefits associated with this practice, there are a number of potential negative implications, including mining the soil, poor crop establishment, exposure of soils to wind and water erosion and a proliferation of weeds.

The theoretical analysis of GRIP revealed that moral hazard was a potential problem with the New Brunswick, Nova Scotia, 1991 Saskatchewan, Alberta and Manitoba programs. The Jackson Offset option in Alberta and the Superior Management Adjustment in Manitoba reduced but did not eliminate this problem. As is described below, this potential did not appear to be manifested with GRIP, as fertilizer and pesticide application remained largely unchanged. Ontario, Quebec and 1992 Saskatchewan GRIP programs had minimum potential for moral hazard.

In 1991 and 1992, all GRIP contracts in all provinces had the effect of increasing expected revenues above what the market offered. The long-term net effect of this may result in increased input usage and adopting more risky crop management strategies than if a less predictable income stabilization program was followed.

HAS GRIP AFFECTED CROPPING AND LAND USE DIVERSITY?

Crop and land use diversity is considered to be important because a more diverse crop mixture should help insulate farmers from the vagaries associated with adverse growing and market conditions. Additionally, greater land use diversity is considered valuable because of the variety of environments available to Canada's flora and fauna.

Over 75% of farmers believed that farming was less risky with GRIP and furthermore, 25% of farmers indicated that GRIP influenced crop selection. With the introduction of GRIP in 1991, a trend was observed in terms of farmers switching to crops such as spring wheat, with higher target revenues. However, this was not at the expense of cultivating grassland or other forages; rather, there was a re-allocation of crops such as oats and a reduction in summerfallow, particularly in the Prairie Provinces. Statistical analyses of primary and secondary data revealed that farmers participating in GRIP tended to have more specialized farms, with cropping emphasis placed on wheat, corn, oilseeds and pulse crops. Under GRIP, already specialized farms remained so or became slightly more specialized because of crop revenue guarantees. A companion analysis of land use diversity based on Canada Census data and the farmer surveys revealed that overall land use diversity did not decrease during the period of assessment. **Thus, we concluded that the overall impact of GRIP on cropping and land use diversity was a negative, minor, short-term impact.** We considered it a short-term impact because a changing market will influence cropping diversity.

HAS GRIP AFFECTED SOIL EROSION AND NON-POINT SOURCE POLLUTION?

Accelerated soil erosion arises when soils are exposed to the influences of wind or water. This erosion removes topsoil and can decrease soil productivity and increase non-point source pollution through the introduction of nutrients, fertilizers and pesticides into receiving waterbodies.

Summerfallow acreage in the Prairies was reduced by 6% (over 500 000 ha) under GRIP, with 15% of the farmers responding to our survey indicating they were influenced by GRIP to reduce their use of summerfallow. GRIP apparently led to the cultivation and re-seeding of 75 000 ha of fall rye crops in its first year of operations which created the potential for soil erosion that winter. GRIP influenced an increase in the use of conservation tillage practices across Canada, with expected associated decreases in erosion. Of interest, was the response by 8% of the farmers surveyed that GRIP influenced them to increase their acreages of forage crops despite the fact that GRIP offers no economic incentives to do so. Parallel analyses using EPIC simulations revealed that environmental impacts of GRIP as measured by mm of soil eroded per year, were negligible (a fraction of a mm per year). GRIP did not appear to pose a threat to sustained soil productivity or increased non-point source pollution even when farming systems as practised under GRIP conditions were simulated for over 100 years.

On balance, there was compelling evidence that GRIP could be considered in its first years of operation to have had **a positive, minor, short-term impact in terms of reduced potential for soil erosion and non-point source pollution.** The degree to which this will hold true for the longer-term is less certain because land use practices might change with a changing market. Nonetheless, simulations suggest that existing farming practices will result in sustained soil productivity for the foreseeable future.

HAS GRIP INFLUENCED THE USE OF CHEMICALS AND AFFECTED WATER QUALITY?

As described above, water quality can be affected by introduction of nutrients and other farm products into receiving waterbodies.

Theoretically, the presence of moral hazard in the GRIP contacts could have led to decreased inputs of fertilizers and pesticides. However, theoretical models, secondary data and farmer surveys revealed that GRIP had no appreciable impact on the use of either fertilizers or pesticides. Thus, impacts on water quality relating to these practices were unlikely. EPIC simulations confirmed no existing or projected increases in non-point source pollution. Conservation farming practices under the GRIP regime should actually lead to reduced erosion and improved water quality. However, given that these improvements would be difficult to detect on a broad geographic basis, it was concluded that **GRIP had a positive, negligible, short-term impact on water quality.** Again, we considered the impact short-term because a changing market could result in changing land use and input use practices.

HAS GRIP AFFECTED WILDLIFE HABITAT INCLUDING WETLANDS?

Farming activities have the potential to decrease wildlife habitats through wetland drainage or cultivation of grassland habitats or conversely, to increase them through conservation-tillage or planting of forage crops.

As far as wetland habitats were concerned, 17% of survey respondents indicated that they had drained wetlands between 1990 and 1992, although the proportion of farmers that attributed this drainage to GRIP was small (less than 5%) of respondents. This provides strong evidence that wetland drainage continued through 1991 and 1992 and that rather than being solely responsible for this drainage, GRIP exacerbated it. A small proportion of respondents (less than 2%) also reported that GRIP influenced cultivation of wetland margins, a zone around wetlands which contributes to wetland functional capability. Despite the fact that these proportions were small and the number and surface areas of affected wetlands were also small, continued long-term degradation of wetlands is likely to lead to more serious problems.

Thus, given Canada's dwindling wetland resource, Canada's position on "no net loss of wetland function", the vulnerability of continental waterfowl populations which rely upon wetlands and their margins, and the stated objectives of the North American Waterfowl Management Plan to increase wetland habitats and waterfowl populations, **the degradation of Canada's wetland resource because of GRIP was concluded to be a negative minor impact in the short-term, but could lead to a negative moderate/major impact in the long-term because of incremental wetland losses.** Given this adverse impact, mitigation measures are recommended. For example, Canada should give consideration to approaches to wetland conservation such as "swampbuster" which has been implemented for U.S. farm programs. This concept should be supplemented with incentives to encourage wetland conservation and creation and should allow for a net gain of wetlands rather than continued degradation of this valuable resource.

For upland habitats, GRIP evidently did not adversely affect grassland or woodland areas in terms of converting them to cultivated lands. Indeed, there was an increase in forage crop acreage which would be beneficial to wildlife. Similarly, the reduction in summerfallow acreage and the adoption of more conservation tillage practices would also be advantageous to wildlife. GRIP did, however, influence a small proportion of farmers in Prairie Canada to cultivate field margins and riparian zones. Despite some declines in upland habitat, there were compensatory increases through changing land use practices that would suggest that for Canada as a whole, **the impact of GRIP on upland habitat was neutral.** This conclusion is not intended to suggest that the identified degradation is acceptable. Rather, mitigation measures such as "sodbuster" should be directed at slowing or halting further loss of these habitats. By invoking such measures, coupled with incentives to encourage more of the identified gains associated with conservation tillage etc., we could begin to see an accrual, rather than a loss of wildlife habitat, similar to what is occurring in the United States.

HAS GRIP AFFECTED AIR QUALITY?

Air quality could be affected by dust arising from soils exposed to wind erosion or through greenhouse gases such as carbon dioxide being released from cultivated lands.

As described above, soil erosion has been reduced under GRIP, which should result in improved air quality through a reduction in wind borne dust. The increase in conservation farming practices and increased forage acreage could also contribute to reduction in carbon dioxide which would otherwise be emitted from summerfallow lands. It would, however, be difficult to detect these improvements in air quality and **thus, GRIP was considered to have a positive, negligible, short-term impact on air quality.** As with water quality, a changing market could result in changing land use and input use practices; hence the designation as a short-term impact.

OVERALL ENVIRONMENTAL IMPLICATIONS OF GRIP

When all the environmental performance measures were considered, it was determined that the impacts of GRIP were both positive and negative, and in some instances neutral. In no instance, however, were those impacts determined to be more than minor in nature, on an impact evaluation scale ranging from negligible through minor, moderate to major.

Based on an evaluation of the first 2 years of GRIP, GRIP's cumulative impact was considered to have been negative and minor; a conclusion triggered by the degradation of wetlands. This degradation, albeit small in scale, was considered to be sufficiently important because of stated Canadian policies for wetland protection, to supersede the several positive impacts of GRIP.

RECOMMENDATIONS

A variety of recommendations are proposed to address the negative environmental impacts of GRIP. These include the following:

- Develop a Canadian equivalent of the United State's "swampbuster" to address concerns relating to the losses of wetland habitats;
- The mechanism for implementation of such an approach could be through conditions under which insurance (program benefits) are withheld, restricted or enhanced for the purpose of protecting the environment as described under FIPA. Examples of conditions under which benefits could be withheld or restricted include draining wetlands or growing annual crops on erosion prone lands. Incentives could also be offered in the form of enhanced crop insurance coverage or reduced premiums for farmers implementing approved farm conservation plans and/or for demonstrating the use of minimum tillage practices or habitat enhancement measures.
- Alter GRIP to make it into more of a whole farm program to encourage greater cropping/land use diversity. GRIP should encompass more farm-related activities, the most notable of which is forage crop production.
- Education including farm extension programs should at a minimum, be maintained and optimally enhanced to encourage farmers to incorporate environmental protection/enhancement practices into their farming operations.

It should be understood that the proposed recommendations would be subject to further evaluation, including consultations with stakeholders prior to implementation.

Beyond the above-described recommendations, there is a requirement to monitor the environmental performance of GRIP. This should include an ongoing evaluation of key environmental indicators including land use, soil conditions, wildlife habitats and air and water quality.

A further evaluation of GRIP's implications to wetlands and other environmental issues will be the focus of the next environmental assessment after 5 years of GRIP.

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1.0 INTRODUCTION

This document reports on the final outcome of the environmental review of the Gross Revenue Insurance Plan (GRIP), based on its first two years of operation in 1991 and 1992. This review was required under the terms of the federal Farm Income Protection Act (FIPA), and has no direct link with the Federal Environmental Assessment Review Process (EARP), nor with the Canadian Environmental Assessment Act.

Environmental assessments of physical projects such as dams or bridges have become commonplace in Canada, because of the recognized potential for such large physical works to alter the environment in ways that may be detrimental. Such assessments are generally carried out before the project is constructed. In contrast, it is less common to assess the environmental impacts of something as intangible as a farm income insurance or stabilization program, particularly after the program has been approved and implemented. Yet that is what this report is about.

The explanation for this unprecedented decision to review the environmental impacts of GRIP is straightforward.

- Agriculture Canada is committed to ensuring that its policies and programs are compatible with the imperatives of environmental sustainability and sustainable development.

- The normal environmental screening of GRIP during the design phase prior to implementation, while generally positive, left some uncertainty because the level of farmer participation in GRIP and their management response to the new program were unclear.

- The government subsidies to farmers under the program, at least in the short term, were expected to be sufficiently large to influence their decisions about land use, and possibly chemical use, in ways that might be detrimental to the environment.

1.1 BACKGROUND

Within Canada's agricultural regions a high proportion of the land area is directly managed by farmers and ranchers. Their decisions about land use, choice of crops, selection of tillage methods, management of agricultural chemicals, and many other factors, have consequences -- both positive and negative -- for the environment.

Farmers' decisions on what and how to produce are influenced by many factors such as local soil and climate conditions, historical and expected commodity prices, etc. The incentives and disincentives provided by agricultural policies and programs may also be important determinants of producer behaviour, and may therefore be indirectly linked to the environmental impacts (both positive and negative) associated with agricultural production.

This is especially true of farm income insurance and stabilization programs during extended periods of low or declining commodity prices, when the net benefits received under the programs tend to be relatively large compared with market receipts.

Historically, insurance and stabilization programs such as crop insurance and Western Grain Stabilization have attracted criticism because of their alleged incentives to use land in unsustainable ways. Today we face the challenge of stabilizing farm incomes without inadvertently rewarding farmers for actions that are incompatible with sustainable development.

Considerable attention was paid to environmental questions in the course of developing the new generation of farm income safety net programs -- the Gross Revenue Insurance Plan (GRIP), and the Net Income Stabilization Account (NISA). A preliminary evaluation of the likely environmental impacts of these new programs reached no definitive conclusions, although certain features of the new programs were felt to be improvements over the older crop insurance and stabilization programs. At the same time, because of the potential magnitude of the subsidies to farmers under these programs, and because GRIP subsidies are not fully decoupled from the production of specific commodities, it was recognized that distortions in land use leading to environmental damage could result. Consequently, when the Farm Income Protection Act (FIPA -- the enabling legislation for GRIP, NISA, crop insurance, etc.) was being drafted, clauses were included to mandate periodic environmental reviews. Specifically, FIPA required that the federal-provincial agreements for every program implemented under the Act:

> 5(2)(a) provide for the circumstances and conditions under which insurance may be withheld, restricted or enhanced for the purpose of protecting the environment and of encouraging sound management practices to ensure environmental sustainability; and
>
> 5(2)(b) require an environmental assessment of the program to be conducted within two years after the coming into force of the agreement and every five years thereafter, and provide for the manner in which the assessment is to be conducted.

Congruent with these requirements, the federal-provincial agreements for the newly developed GRIP and NISA contained clauses which defined the understanding attained between federal and provincial governments with regards to these activities (see sections 19.1 to 19.4 of the National Agreement Establishing a Tripartite Gross Revenue Insurance Plan and Sections 6.6 and 6.7 of the Federal-Provincial Agreement Establishing the Net Income Stabilization Account Program). Specifically, both agreements called for an environmental assessment within two years of the agreements coming into effect. Consequently, in May

1992, Agriculture Canada contracted Environmental Management Associates to conduct environmental assessments of GRIP and NISA.

Under the Federal-Provincial Agreement, GRIP is defined as a "Gross Revenue Insurance Program that combines the protection offered by a crop insurance component and the protection offered by a revenue protection component." The original intention of the Federal government was that GRIP would be a single program integrating crop insurance with revenue insurance. However, in the transition years (1991 and 1992) following introduction of GRIP, the two components of GRIP were delivered separately in most provinces, so that, in effect, there are two programs viz crop insurance and GRIP (revenue insurance). In most farmers' minds GRIP is synonymous with revenue insurance, as distinct from crop insurance. As FIPA and the Federal-Provincial Crop Insurance Agreement require a separate environmental review of crop insurance, the present assessment focuses primarily, but not exclusively, on the revenue insurance component of GRIP.

Potential environmental assessment issues related to the GRIP and NISA programs involve changes in the environment indirectly linked to the programs. Some changes may tend to stabilize agro-ecosystems while others will be destabilizing. This assessment will not provide a definitive answer to the question of whether the production of grains and oilseeds in Canada is environmentally sustainable; rather, it will assess whether GRIP/NISA-induced changes are a stabilizing or a destabilizing influence on selected components of agro-ecosystems and the broader environment. Conceptually, a precondition for GRIP and/or NISA to have environmental impacts is that some of the program participants must behave differently after entering into GRIP and/or NISA contracts with the government.

1.2 OBJECTIVES

In general, the main objective was to ascertain whether GRIP, during its first two years of operation, influenced farmers to modify their crop selection, land use, chemical use and management practices in a way that would result in harmful impacts to wetlands, wildlife habitat, soils, water quality or air quality.

A key objective was to keep the assessment as realistic as possible, by comparing what actually happened before GRIP, with what actually happened after the introduction of GRIP. Hypotheses regarding environmental impacts that might have occurred in the complete absence of any safety net program were considered to be both unrealistic and essentially impossible to assess without a great many additional assumptions and hypotheses about support programs for other commodities (red meats; horticulture) both domestic and foreign. The emphasis throughout this report is therefore on relative incremental changes in the environment induced by GRIP, rather than on absolute total measures of environmental impact.

There were three additional objectives in this assessment. One was to provide farmers themselves with an opportunity to directly participate in the review, and to do so in a way that would permit statistically valid conclusions to be reached about the behaviour of the entire population of GRIP program participants. The second objective was to allow for broad participation by any interested individual, farm organization or environmental interest group. This latter objective was achieved by inviting written submissions, while the former objective was accomplished by means of a mail out survey, following Dillman's (1978) Total Design Method.

The final objective was to produce a report suitable for submission to Ministers and to Parliament, containing recommendations on mitigation measures, environmental indicators, and a national monitoring program. It was specifically required that the report contain recommendations on how to define the circumstances and conditions under which insurance (i.e., GRIP) should be withheld, restricted or enhanced for the purpose of protecting the environment, as required by the Farm Income Protection Act.

1.3 GROSS REVENUE INSURANCE PLAN (GRIP) DESCRIPTION

GRIP is a national safety net program for agricultural crop producers, including producers of feed grains. This tripartite program is cost-shared by both the federal and provincial governments and producers. GRIP is administered by provincial crop insurance agencies. The plan offers producers of eligible crops a combination of yield and price protection.

At the present time, GRIP is being delivered through two components viz. crop insurance for the yield side, and a separate revenue insurance component for the price side. It is likely that this duality of delivery mechanisms will continue beyond the transition year in some provinces.

The yield insurance component is little different from the current crop insurance program. Premiums will be shared 50% by the producer, 25% by the federal government and 25% by the provincial government.

Producers are encouraged to sign up for revenue protection at the same time as they sign up for crop insurance. Premiums are shared 33.33% by the producer, 41.6% by the federal government and 25% by the provincial government. (During the transition year, the Farm Support and Adjustment Measures (FSAM) provide special subsidies to the provincial and producer premiums). A national base premium is set; the producer's share of the base premium will not increase by more than two percentage points during the first five years of the program.

Producers have the choice of enroling in either the crop insurance component, the revenue protection component or both. Farmers participating only in the revenue protection component pay more for that component than if they had participated in both components. Farmers who enrol in the revenue protection component must enrol all of their eligible crops. Farmers may choose to enrol only certain crops in the crop insurance component. Eligible crops in Western Canada include all crops covered under WGSA - wheat, oats, barley, rye, flax seed, canola/rapeseed, mustard seed, triticale, mixed grain, sunflower seed, safflower seed, buckwheat, peas, lentils, fababeans, canary seed, and farm-fed grains. In Eastern Canada, eligible crops include corn, soybeans, canola, oats, barley, winter and spring wheat, and farm-fed grains.

Participating producers will be able to opt out of GRIP by giving three years advance notice. They must wait two years before re-enroling in the program and full coverage will not be available for two additional years.

As with any insurance program, there will be times when the program goes into a deficit situation. This is expected to occur at least during the first year of operations as payments will exceed the premiums collected. The federal government will advance 65% of the deficit and the provincial government 35%. However, this is not a grant to producers; there is a mechanism in place to recoup these advances with interest.

At the federal level, the revenue protection component of GRIP will be administered by the Crop Insurance Division of Agriculture Canada. This Division will liaise with the provinces responsible for controlling the delivery of the program. The federal and provincial governments will both promote the program. Provinces will administer on-farm inspections to obtain yield data, and manage both components of GRIP, namely crop insurance and revenue protection.

1.4 GRIP AND A DESCRIPTION OF PROVINCIAL PROGRAMS

The GRIP agreement between the provinces and the federal government outlined the specific design features which were to be implemented across the nation. Under the Federal-Provincial Agreement, GRIP is defined as a "Gross Revenue Insurance Program that combines the protection offered by a crop insurance component and the protection offered by a revenue protection component." The original intention of the Federal government was that GRIP would be a single program integrating crop insurance with revenue insurance. However, in the transition years (1991 and 1992) following introduction of GRIP, the two components of GRIP were delivered separately in most provinces, so that, in effect, there were two programs viz crop insurance and GRIP (revenue insurance). In most farmers' minds, GRIP is synonymous with revenue insurance and is distinct from crop insurance. As FIPA and the Federal-Provincial Crop Insurance Agreement require a separate environmental review of crop insurance, the present assessment focuses primarily, but not exclusively, on the revenue insurance component of GRIP.

The discussion that follows describes the intended GRIP design (IGRIP) and summarize each of the provincial modifications. It shows how each program differs and what modifications were done. Since each province made its own agreement with the federal government, each program has its own unique features added, but the basic concept of the program still remains intact.

1.4.1 Intended GRIP Design (IGRIP)

The IGRIP design was to provide a grain producer with a guaranteed minimum gross revenue per acre (target revenue). This program was to be integrated into crop insurance or it could be delivered separately from crop insurance. There were to be two pay-out components and premiums, namely, revenue insurance and crop insurance. Target revenue (TR) was to be calculated by multiplying a farmer's long-term average yield (LTAY) by seventy percent of the indexed moving average price (IMAP). The IMAP is the previous fifteen year real price series for each crop lagged by two years. It is converted to current nominal dollars through the Farm Input Price Index (FIPI). Because individual LTAY's were not available for every farmer, this was one rationale for allowing each province to determine a procedure for estimating this parameter.

If a crop insurance contract was taken by a farmer, this meant the premium provided a minimum yield guarantee. If crop production fell below the minimum, the revenue difference was indemnified by the crop insurance agency. Revenue insurance provided by the GRIP contract was intended to have offsets between prices and yields. A GRIP indemnity occurs when market revenue falls below the target revenue. In other words, if either a drop in market prices is offset by higher yields or lower crop yields are countered with increased market prices so that market revenue exceeds the target revenue, then no pay-out is called for. Thus, IGRIP was designed to be a predictable individualized program in terms of stabilizing income which is specific to the crop in question. Every producer would know the minimum return per area seeded to each crop prior to planting.

1.4.2 Summary of the Provincial GRIP Programs

New Brunswick, Nova Scotia and the 1991 GRIP program in Saskatchewan operated very close to the IGRIP. They had the greatest potential for moral hazard because there were no special provisions to adjust the level of yield coverage. Saskatchewan 1992 GRIP program minimized moral hazard because it shifted revenue insurance to price insurance. Like the Ontario GRIP program, the 1992 Saskatchewan program was basically a price deficiency program but the deficiency payment was based upon the composition of crops grown in the area, not the specific crop. By basing the deficiency payment on a basket of GRIP eligible crops, the 1992 Saskatchewan program was neutral with respect to selecting which GRIP eligible crop to grow but has a built in incentive not to produce crops outside of GRIP. The Saskatchewan GRIP ranked highest in terms of minimizing moral hazard, and neutrality with respect to production and marketing decisions. This was followed by Quebec GRIP with comparable moral hazard but less neutral in terms of crop selection. Moral hazard was minimized in the Ontario program (OGRIP), but because the IMAP prices were the basis for determining each crop's annual GRIP indemnity, these potential payouts introduced non-neutral incentive in terms of which crops are produced. In the case of Alberta farmers electing the Jackson offset the problem of moral hazard was reduced, but was present for those not choosing this option. Similarly, in Manitoba the SMA adjustment was retroactive, but farmers must choose whether they believe the cost of attaining higher yields will be rewarded through potentially higher GRIP indemnities. Some may choose to reduce inputs and accept the IGRIP payouts, while others will aim for higher GRIP indemnities by using more inputs. Because GRIP indemnities were crop specific in Manitoba, the program will have a bearing on crop selection.

In 1991 and 1992, all the GRIP contracts increased the expected revenue from nearly all the eligible crops because the target revenues exceeded expected market revenues with no insurance or historical stabilization programs. Because GRIP is more predictable than NISA or other past stabilization programs, the probability of an indemnity payment can be factored more readily into a farmer's crop production decision. This has the effect of increasing the expected revenue from all eligible crops as well as reducing the variability of annual returns. The long term net effect will likely result in increased input usage and adopting crop management strategies which will tend to be more risky than if a less predictable income stabilization program was followed.

1.5 ORGANIZATION OF REPORT

The document is composed of two sections. Section one describes GRIP, the nature of the environmental issues that might be related to GRIP and the approaches adopted to gather information for the subsequent assessment. Specifically, this section contains the following chapters and content:

2.0 - Environmental assessment issues in Canadian agriculture and commonly posed GRIP questions

3.0 - The analytical framework used to undertake the assessment

Section two of the document consists of the data gathered to facilitate the assessment, the actual assessment, mitigation measures associated with identified impacts and recommendations for GRIP program amendments. Specific components of this section include:

4.0 - Theoretical and conceptual assessment

5.0 - Assessment with descriptive approaches of primary and secondary data

6.0 - Assessment of secondary data such as Census data with statistical methods

7.0 - Simulation studies to assess soil erosion

8.0 - Integration, conclusions, and recommendations for program changes

2.0 ENVIRONMENTAL ASSESSMENT ISSUES

2.1 CANADIAN AGRO-ENVIRONMENTAL ISSUES

The principal environmental issues in Canadian agriculture were described in a 1989 report to federal and provincial Ministers of Agriculture, by the Federal-Provincial Agriculture Committee on Environmental Sustainability. The report identified 17 specific sub-issues; they are grouped under 8 headings as follows:

1. Agricultural Soil Resources
    - soil degradation
    - urban encroachment on farmland

2. Surface and Groundwater Quality
    - contamination by pesticides
    - contamination by nutrients
    - contamination by manure and other by-products
    - contamination by agricultural soil sediments

3. Water Quantity
    - excess or inadequate water supplies

4. Wildlife Habitat
    - conservation of habitat

5. Air and Climate
    - stratospheric ozone depletion
    - air quality
    - climate change

6. Energy
    - energy inefficiency
    - lack of alternative sources

7. Pollution and Waste Management
    - effects of pollution on agri-food sector
    - contribution of agri-food sector to industrial pollution

8. Genetic Resources
    - loss of genetic diversity
    - narrowing of the genetic base for agriculture

Similar issues were identified in the most recent State of the Environment Report for Canada (Environment Canada 1991).

Although there is some regional variation in the environmental problems, there are a few issues which are common to most agricultural regions of Canada. These are soil erosion, water quality concerns, destruction of wildlife habitat, and global warming (greenhouse gas emissions). The draining of wetlands also is a national problem.

In general, the objective of the review was to assess whether, and to what extent, GRIP was implicated in the above environmental issues during its first two years of operation.

2.2 PROVINCIAL ISSUES

A summary of agri-environmental issues was compiled from the literature and the structured interviews undertaken across Canada as part of this study. The key issues identified for each province are illustrated in a matrix (Figure 2.1).

2.3 SPECIFIC ASSESSMENT QUESTIONS FOR GRIP

2.3.1 Background

In Sections 2.1 and 2.2, the principal environmental issues in the Canadian agri-food sector were identified and briefly discussed. In general, the objective of this environmental review of GRIP was to assess whether, and to what extent, GRIP may be implicated directly or indirectly in those environmental issues.

The desire on the part of policy makers to ensure that the new generation of farm safety net programs would be environmentally more sustainable than the older programs they were replacing, had already led to preliminary attempts to assess the environmental implications of the various new program options under consideration during the design phase. However, these early assessment attempts had been largely qualitative, and were hampered by inadequate information and data. Ultimately, no definitive conclusions were reached prior to introducing GRIP and NISA, although certain features of the new programs were thought to be improvements over the older programs such as the Western Grain Stabilization Program. But the basic concerns remained: How will these new programs influence the production decisions of farmers, and with what environmental consequences for wetlands, soils, wildlife habitat, water quality and air quality?

Through a combination of literature review and structured face-to-face interviews with resource professionals in each province, seventeen specific environmental assessment questions were identified. These were grouped under eight main headings as follows.

FIGURE 2.1

ENVIRONMENTAL ISSUES IN THE CANADIAN AGRI-FOOD SECTOR[a]

ENVIRONMENTAL ISSUE	B.C.	ALTA.	SASK.	MAN.	ONT.	QUE.	NEW BRUNS.	NOVA SCOTIA	PEI	NWFLD
SOIL DEGRADATION										
• wind erosion	✓	✓	✓	✓	✓		✓			✓
• water erosion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
• organic matter loss	✓	✓	✓	✓			✓	✓	✓	✓
• soil compaction	✓				✓	✓	✓	✓	✓	✓
• acidification							✓	✓	✓	✓
• contamination					✓					
• salinization		✓	✓	✓						
WATER QUALITY/FISH										
• fertilizer contamination	✓			✓	✓	✓			✓	
• pesticide contamination	✓			✓	✓	✓			✓	
• animal waste	✓	✓	✓	✓	✓	✓	✓	✓	✓	
• water availability		✓	✓	✓						
• flooding	✓			✓	✓	✓	✓	✓	✓	
HABITAT DEGRADATION										
• wetland drainage	✓	✓	✓	✓	✓	✓	✓	✓	✓	
• upland clearing	✓	✓	✓	✓						
AIR QUALITY/CLIMATE										
• dust/odour		✓	✓	✓	✓					
• greenhouse gas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENERGY										
			✓		✓					
GENETIC RESOURCES										
			✓							

[a] Derived from review of major documents and structured interviews.

2.3.2 Land Use and Cropping Diversity

Question 1. Does the reduction in market risk afforded by GRIP affect producers' decisions regarding which crop(s) to grow, total acreage for specific crops, summerfallow acreage, or total cropped acreage?

Question 2. Does GRIP contribute to increased or decreased specialization, and does this affect minor crops?

Land use implications of GRIP have been considered of prime importance by various interest groups. Most of the environmental criticism directed at GRIP has been linked to land use, specifically to changes in areal coverage of various crops as well as the intensification and specialization of farming practices.

It has been suggested that guaranteed revenue combined with the commodity-specific coverage offered under GRIP will further reduce any incentive to diversify production as a strategy for dealing with production and market risk. This could result in increased seeded acreage and the resulting cultivation of environmentally sensitive areas. Shifts in crop mixes favouring one or a few commodities also may result in expansive monocultures, which in turn results in increased soil degradation in the form of organic matter losses and increased erosion (Environment Canada 1991).

Diversification within agriculture is desirable as a means of enhancing environmental sustainability and possibly economic stability for individual producers. Diversification may take the form of longer rotations incorporating a broader range of crops, or a better balance of cropping and livestock enterprises, both regionally and at the individual farm level (Altieri 1987).

For many years it was believed that farming sectoral productivity, growth and competitiveness could be improved by assisting the sector to specialize, expand and intensify production. The chief impediment standing between producers and the higher short-term economic returns associated with specialization has always been the greater income risk inherent in putting all one's eggs into one basket. Insurance programs were designed to address this impediment to specialization.

Unfortunately, specialization is strongly linked to many of the current resource base and environmental concerns that now confront us. Without insurance programs which promote specialization, the rational response to risk would be diversification. Any program that actively reduces income risks without simultaneously promoting more and longer rotations, mixed crop/livestock farming, conservation tillage systems and related environmental protection measures, may contribute to the environmental problems that result from specialization.

At present, premiums and payouts under GRIP are crop-specific. Undoubtedly, rational producers take price and revenue guarantees into account when making their decisions on what and how much to plant. This may result in shifts in the crop mix that are inconsistent with what a free market would have dictated. The ensuing crop mix may be characterized by a lower level of diversity, as indicated by numerical measures of diversity, and by greater stress on the environment in the form of organic matter losses, increased fertilizer use, soil compaction and increased soil erosion (Environment Canada 1991).

Corporate splitting is a component of the moral hazard problem. In this case, families may elect to split their farms in order to increase their total access to the subsidy component of the program. If the splitting results in monocultural enterprises on the different parts of the corporate farm (e.g., father grows only corn, while son grows only wheat) there could be a negative effect on the environment as discussed above.

Neutrality with respect to producer decisions on what to plant was one of the key criteria for assessing safety nets, according to the Federal-Provincial Safety Net Committee. However, there are concerns that GRIP is not neutral. Indeed, at least one interviewee per province voiced concerns that GRIP might encourage large monocultures of crops that are "the most profitable" under the existing GRIP payout regime. Interviewees were concerned that, if large crop monocultures become a reality under GRIP, they would adversely impact soil quantity and quality, water quality, and ultimately wildlife populations.

2.3.3 Marginal Lands, Wetlands and Wildlife Habitat

Question 3. Do the government subsidies provided through GRIP, and the partial insulation from market signals which results from the 15-year indexed moving average price (IMAP), distort land use in ways that affect marginal lands, wetlands, wildlife habitat, or contractual set aside lands such as those in the Permanent Cover Program?

Land use concerns in agriculture generally relate to marginal lands that cannot physically sustain viable annual crop production, either in and of itself or using traditional production techniques. Marginal lands are environmentally sensitive because of their biophysical characteristics as wildlife habitat, wetlands, riparian zones, native prairie and/or highly erodible lands. Marginal lands have consistently been vulnerable to development as a result of economic pressures on producers. For example, as of 1990, over 71% of Canada's wetlands had been drained and 82% of prairie wetland margins had been cleared or cultivated for agricultural expansion (Environment Canada 1991). Agriculture Canada stated that GRIP should not encourage the breaking up of new land at the expense of wetlands, native prairie and other wildlife habitat areas. Moreover, the Federal-Provincial Safety Net Committee stated, "programs should not encourage cereal production on fragile lands." This was one of the criteria for evaluating safety net programs that the Safety Net Committee developed.

In its present format, GRIP does not appear to provide any specific disincentives to undesirable modifications in land use, particularly in environmentally sensitive areas. But, prior to this assessment, the critical question related to land use, "How does GRIP influence the use of marginal lands?" was unanswered. Several Canadian agricultural economists have suggested that GRIP may encourage farmers to break up marginal lands (Gray et al. 1991). These concerns have been echoed by Environmental NGO's, the United States Department of Agriculture and others.

During the structured interviews, interviewees from Alberta, British Columbia, Manitoba, Ontario, and Saskatchewan voiced concerns about the possibility of GRIP encouraging farmers to bring marginal lands into production. These concerns were most pronounced in the Prairie Provinces, where all remaining wetlands and the adjoining upland margins have been targeted for protection under the North American Waterfowl Management Plan.

Agriculture, especially on the Prairie Provinces, has had serious consequences for natural ecosystems with regard to species diversity and numbers. The Canadian Prairies are the major nesting grounds for many of North America's waterfowl and other bird populations. The conversion of about 3 million acres of wetlands to grain production has eliminated roughly 40% of Canada's prairie wetland habitats and the associated wetland species (USFWS/CWS 1986). The primary objective of the North American Waterfowl Management Plan's (NAWMP) Prairie Habitat Joint Venture is to protect and enhance 3.6 million acres of waterfowl habitat in Manitoba, Saskatchewan, and Alberta. Several interviewees from these provinces were concerned that GRIP would encourage farmers to drain wetlands and/or destroy the critical upland margins adjacent to these wetlands. If GRIP encourages wetland habitat destruction, it is in direct conflict with the NAWMP. Additionally, wetland destruction reduces the recharge capacity of underground aquifers, reducing both the quantity and quality of groundwater supplies.

Due to the costs of converting wetlands and other wildlife habitat such as woodlots to annual crop production, the economic incentives to continue this trend will depend directly on prices that farmers receive from the marketplace and on the magnitude of ongoing financial support from governments to maintain net incomes in crop production. Interviewees in all provinces except Ontario voiced concern that GRIP might encourage wetland and woodland conversion to croplands due to the acreage-based nature of the program and the relatively high level of financial support it presently provides. Moreover, several interviewees voiced concern that existing wildlife/soil conservation easement programs might not be able to compete with GRIP; hence, an unknown portion of lands currently protected for wildlife/soil conservation might be converted to GRIP-eligible croplands.

2.3.4 Chemical Use and Contamination

Question 4. Does risk reduction under GRIP, and/or any distortions in land use or crop selection, affect producers' decisions on chemical use, and the total amount of chemicals used in Canadian agriculture?

Question 5. Does indexing IMAP by the Farm Input Price Index (FIPI) in any way insulate farmers from the normal economic effects of rising chemical input prices?

Question 6. If GRIP influences chemical use, does this result in increased or decreased contamination of surface water or groundwater?

There are two aspects to the input use issue in relation to GRIP: (1) moral hazard, which may cause under-use of fertilizers and/or pesticides resulting in mining the soil, poor crop establishment, exposure to wind erosion and proliferation of weeds; and conversely (2) built-in inflation protection, which removes any incentive to reduce chemical use even when input costs increase or commodity market prices decrease.

When expected prices are so low that there is little probability that market returns can exceed the GRIP guarantee, producers may choose to accept the guarantee and maximize income by minimizing expenditures on fertilizer, pesticides, etc. Several interviewees in the Prairie Provinces voiced concerns over this type of scenario occurring in the short term. Additionally, producers nearing retirement or facing financial difficulty may have an incentive to reduce seeding or harvest efficiency through reduced input usage or poor harvest practices. By so doing, payouts would be triggered. Adjustments through raised premiums or reduced coverage would lag behind. While it could be argued that these moral hazard components might provide environmental benefits due to the reduction of chemical inputs, the overall effect would likely be decreased crop vigour which in turn would result in soil degradation due to increased soil exposure to wind and water erosion, increased organic matter losses and increased soil compaction.

Moving to the other end of the spectrum from moral hazard concerns, GRIP should not, according to the Federal-Provincial Safety Net Committee, "...encourage excessive use of particular inputs such as pesticides and fertilizers by either subsidizing these inputs directly or making stabilization payments from the second line based on changes in their costs." However, concerns have been expressed that GRIP would provide higher margins per tonne of output in crop production that would tend to increase fertilizer and pesticide use. Interviewees in Alberta and Manitoba echoed these concerns.

There are growing public concerns about water quality. With regard to agriculture, these concerns generally focus on pesticides and fertilizers polluting groundwater supplies used by urban populations (this seems to be more of a problem outside of the Prairies given the area's low population densities relative to the agricultural land base). However, soil erosion and fertilizer/pesticide runoff also adversely impact water quality by entering surface waters via surface runoff (Environment Canada 1991). Soil erosion causes increased sediment loading and sedimentation, fertilizers increase nutrient loading, and pesticides can potentially kill plants and animals associated with pond, lake, and riverine systems.

Several individuals and agencies were of the opinion that GRIP would negatively impact soil conservation as well as increase long-term fertilizer and pesticide inputs. Hence, there is concern that GRIP could adversely impact ground and surface waters, and the associated fisheries and wildlife populations. Additionally, there was concern that GRIP might encourage farmers to cultivate wetland and riparian margins, thereby eliminating these critical "buffer zones" to upland runoff and exacerbating the water quality concerns.

Another potential impact of cultivating marginal land, includes the need for increased irrigation. Between 1970 and 1988, the total agricultural area in Canada, utilizing irrigation more than doubled. Environmental concerns associated with increased irrigation of marginal lands include the increased use of pesticides and fertilizers required in comparison to non-irrigated land, as well as the potential for salinization and leaching of salts and other minerals from irrigated soils to nearby waterways and groundwater (Environment Canada 1991). Moreover, many areas throughout Canada are experiencing shortages in available water for irrigation, without the construction of expensive reservoirs.

2.3.5 Impacts on Livestock Sector and Diversification

Question 7. Are there any features of GRIP as currently implemented that affect cattle production either positively or negatively, and with what environmental consequences?

Question 8. Does the failure to cover forages or to offer whole farm coverage affect the livestock sector, or influence the level if diversification?

The Canadian Cattlemen's Association is one of many groups and individuals to criticize GRIP for failing to cover forages. Both for annual and perennial forage crops, the failure to provide coverage implies a failure to achieve neutrality with respect to land use. Consequences could include disincentives to integrate crop and livestock production and in particular to grow forages which provide good protection against soil degradation (Dawson and Elofson 1991).

In relation to annual forage crops (cereal silage, corn silage, corn, peas, cereal pasture, greenfeed), the National GRIP Committee's 'Forage Working Group' agreed that "...all annual forage crops (with the exception of cereal pasture in some instances) compete directly for the use of land each year with the present GRIP crops, and are priced or valued in relation to the market price of GRIP crops."

Interviewees in Alberta, British Columbia, Manitoba, Ontario, and Saskatchewan voiced concerns over the failure of GRIP to cover forages. Several interviewees pointed out that, in addition to providing better protection from soil degradation than most GRIP crops, annual and perennial forage crops also provide better wildlife habitat. Moreover, several interviewees from the Prairie Provinces noted that forages in their region are usually associated with marginal lands [i.e., wetlands and Canada Land Inventory (CLI) Class 5 and 6 lands]; hence, the conversion of these areas to GRIP-eligible crops would exacerbate the aforementioned concerns.

2.3.6 Cultural Practices and Innovation

Question 9. Do the terms and conditions or any other contractual features of GRIP affect producers' decisions regarding the choice of production system or technology?

Question 10. Are organic producers or farmers who use innovative or alternative production systems eligible to participate in GRIP?

Question 11. What are the environmental consequences of any identified incentives or disincentives to the adoption of conservation practices under GRIP?

The Safety Net Committee stated, "...programs should neither encourage inefficient cultural practices nor those which may harm the environment by degrading the resource base." Crop insurance programs, and now GRIP, have been criticized for erecting barriers to the adoption of innovative conservation practices such as no-till, ridge tillage, reduced tillage, and low-input production systems in general. Frequently, the early years following adoption of sustainable production systems are marked by lower yields compared with conventional systems; this leads to lower coverage levels or higher premiums. When producers are directly or indirectly penalized under an insurance program because of their efforts to conserve resources or protect the environment (Ducks Unlimited 1991), then it can be argued that there is a defect in the program. In this context it is worth recalling that FIPA -- the enabling legislation for GRIP and NISA -- states, as one of its fundamental principles, that programs should encourage long term economic and environmental sustainability.

Interviewee opinions were mixed about GRIP's potential effect on conservation farming practices. Some interviewees, voicing the rationale outlined above, believed GRIP might discourage farmers from implementing zero- or minimum-till farming practices, while others believed GRIP might actually increase zero-tilled acreage. The latter group believed that GRIP would provide a predictable income, thereby allowing farmers to better forecast their revenues and purchase zero-till drills.

2.3.7 Soils

Question 12. Do distortions in land use under GRIP result in increased or decreased soil degradation?

By introducing a new set of incentives and disincentives, GRIP may adversely affect soil conservation efforts of farmers. This is another aspect of resource neutrality that overlaps with the previous section on land use practices. The critical question is, does GRIP reward efforts to conserve soils and protect the environment or does it act as a barrier to investments in soil conservation?

The major soils issues associated with GRIP appear to be organic matter loss and wind/water erosion caused primarily by inappropriate tillage practices and crop selection/rotation. Interviewees in all provinces voiced concerns about these issues.

2.3.7.1 Organic Matter Loss

Organic matter loss reduces the physical properties of the soil resulting in lower yields over time and greater susceptibility to water/wind erosion. The loss of organic matter is primarily a problem in certain regions of the Canadian Prairies. Organic matter loss is exacerbated by summerfallowing, and inappropriate tillage practices and crop selection on sensitive soils (e.g., CLI Class 4-6 lands). Most interviewees felt GRIP would decrease summerfallow acreages, thereby providing a positive impact on soil quality. However, the impact of GRIP on tillage practices and crop selection was of concern to several interviewees.

2.3.7.2 Water and Wind Erosion

Soil degradation resulting from top soil erosion by wind and water is the most wide-spread agricultural problem in Canada. Soil erosion results in a loss of topsoil and, in severe cases, the upper part of the subsoil. The consequences of erosion include risk of further erosion, decreased yields that generally cannot be offset by increased use of chemical fertilizers and water quality problems from sedimentation and fertilizer and pesticide runoff (Environment Canada 1991).

Wind erosion is a serious concern on the Prairies, whereas water erosion is relatively more of a problem in eastern Canada and in the Peace River District of western Canada. As with soil organic matter loss, excessive summerfallowing, and inappropriate tillage practices and crop selections are major contributors to wind and water erosion. As indicated above, interviewees were concerned that GRIP might adversely change current tillage practices and crop selection such that wind and water erosion could increase.

2.3.8 Air Quality

Question 13. Does GRIP affect air quality directly or indirectly through its influences on land use, chemical use, soil conservation or any other factor?

The Intergovernmental Panel on Climate Change (1990) estimates that agriculture contributes 14% to the increased atmospheric build-up of greenhouse gases. Crop production, especially grain/oilseed production, is the most fuel intensive sector in agriculture. Higher margins in the grain sector will provide incentives to retain marginal land in annual crop production, thereby increasing the amount of fossil fuel used in agriculture. However, air quality specialists that were interviewed felt that any changes in fuel consumption due to GRIP would be inconsequential compared to the existing nonagricultural fuel consumers.

In addition to fossil fuel impacts, increased cultivation and land break-up results in the release of carbon dioxide from soil organic matter and the increased use of fertilizers can lead to the emission of nitrous oxide to the atmosphere (Environment Canada 1991). Moreover, some interviewees voiced concern over the negative effect that cultivating grasslands (areas that essentially serve as carbon sinks) would have on the greenhouse effect. However, it was unclear what, if any, measurable impact grassland conversion to cropland would have on air quality or the greenhouse effect.

The only other air quality concerns identified with GRIP were those related to airborne particles. In recent years, the relaxation of conservation measures such as strip cropping and windbreaks has resulted in a serious increase in the occurrence of wind erosion and consequently airborne dust particles, particularly on the Prairie Provinces (Environment Canada 1991). The attachment of fertilizers and pesticide residues to these airborne dust particles, further complicates the potential environmental impacts and risk to human health associated with poor soil management.

2.3.9 Other Evaluation Questions

Question 14. How would offsets between commodities under a "basket of commodities" approach affect crop selection, land and chemical use, and associated environmental impacts?

Question 15. From an environmental perspective, what are the advantages and disadvantages of individual coverage compared to area average coverage methodologies?

Question 16. In light of the environmental assessment findings, what specific changes and amendments to GRIP are recommended in order to make the program more environmentally sustainable?

Question 17. Pursuant to Section 5(2)(a) of the Farm Income Protection Act, what are the recommended "circumstances and conditions" under which insurance might be withheld, restricted or enhanced for the purpose of protecting the environment?

2.4 SUMMARY

Just as the environmental problems in the Canadian agri-food sector varied from province to province, so too did the assessment issues. This is a consequence of both the unique environmental conditions in each province across Canada, as well as the varying details of GRIP from province to province.

Issues which were prevalent across the country are summarized below.

LAND USE

- The potential for the acreage-based nature of GRIP contributing to growing of crops on unsuitable lands. This could be manifested in farming lands with poor soil quality leading to erosional problems or farming lands that might otherwise be used for purposes such as wildlife habitat.
- The potential for adverse crop selection leading to concerns such as monocultures and reduction in crop rotations which in turn can contribute to problems such as soil erosion.
- The potential for GRIP encouraging or deterring the use of conservation farming practices.
- Concerns that exclusion of forages from GRIP may deter mixed-farming enterprises and degrade existing wildlife habitats on agrarian settings.

SOILS

- Soil degradation concerns associated with farming GRIP-eligible crops on sensitive lands (i.e., CLI class 4-6 lands).
- The elimination or reduction in crop rotations arising from GRIP would result in degraded soil quality.
- Certain GRIP crops such as lentils and corn provide poor ground cover which in turn can lead to increased erosion problems.

FERTILIZER AND PESTICIDE INPUTS

- When expected prices are so low that there is little probability that market returns can exceed the GRIP guarantee, producers may choose to accept the guarantee and maximize income by minimizing expenditures on fertilizer, pesticides, etc. (i.e., moral hazard).
- Conversely, GRIP might provide higher margins per tonne of output in crop production that would tend to increase fertilizer and pesticide use.

WILDLIFE HABITAT

- GRIP might encourage farmers to convert important wildlife habitats (i.e., woodlands, native grasslands, wetlands) into GRIP-eligible crops because of the acreage-based nature of the program.

- GRIP might discourage forage crops and pasture lands, thereby adversely impacting wildlife species that are dependent on these areas to meet all or a portion of their life-history requirements.

WATER QUALITY AND FISHERIES

- Increased fertilizer use could contribute to nutrient loading in receiving waterbodies.
- Increased pesticides could adversely impact water quality, causing mortality to unknown numbers of fish species.
- Increased sediment loading into watercourses arising from increased water erosion would degrade water quality and fisheries habitat.

AIR QUALITY

- The potential for GRIP-altered agricultural practices contributing to Greenhouse gasses.
- Increases in the occurrence of wind erosion and consequently airborne dust particles, particularly in the Prairie Provinces.

The goal of the assessment was to address the assessment issues and questions identified in this chapter. In the next chapter, the analytical framework for addressing these issues and questions is presented.

3.0 ANALYTICAL FRAMEWORK FOR THE ASSESSMENT

3.1 INTRODUCTION

The primary objectives of the environmental review of GRIP were to: (1) evaluate if the program has had impacts (positive or negative) on the biophysical environment and (2) recommend future actions to minimize any negative impacts that are discovered. In particular, our goal was to address the environmental assessment issues and questions identified in chapter 2. In order to do this, an analytical framework was used. This process followed that developed by Conover et al. (1985), where a systematic approach was employed to use quantitative/analytical methods when possible, yet allowed for the use of qualitative methods where necessary.

This framework comprised six components or lines of investigation as follows:

i) Conceptual or theoretical examination of incentives under GRIP;

ii) Simple description of information gathered through literature review, written submissions, survey of program participants, and other means;

iii) Statistical studies of historical data, GRIP data, and survey data;

iv) Simulation studies of soil degradation and non-point source pollution using the EPIC model;

v) Synthesis, integration and rationalization of the findings from each of the above components of the assessment, leading to conclusions;

vi) Examination of mitigation measures, and development of recommendations.

A conceptual illustration of information flow through the assessment process is illustrated in Figure 3.1. Essentially, primary information and data were acquired directly from farmers who were participating in the program, by means of a mail survey. Secondary information and data, including historical land use and chemical data, were obtained through literature reviews and from Statistics Canada, Agriculture Canada, provincial crop insurance offices, and other sources. Concurrent to the collection of primary and secondary data for analyses, a conceptual or theoretical assessment of program influences on farmers' decisions was undertaken.

The primary level of stratification for the environmental assessment was the major soil regions identified in Agriculture Canada's publication "Soils of Canada." Soils within these various regions have different susceptibilities to wind and water erosion, soil organic matter depletion, water quality degradation, salinization, and have marginal to high capabilities for agriculture and wildlife. Hence, stratification by soil region enabled us to assess the

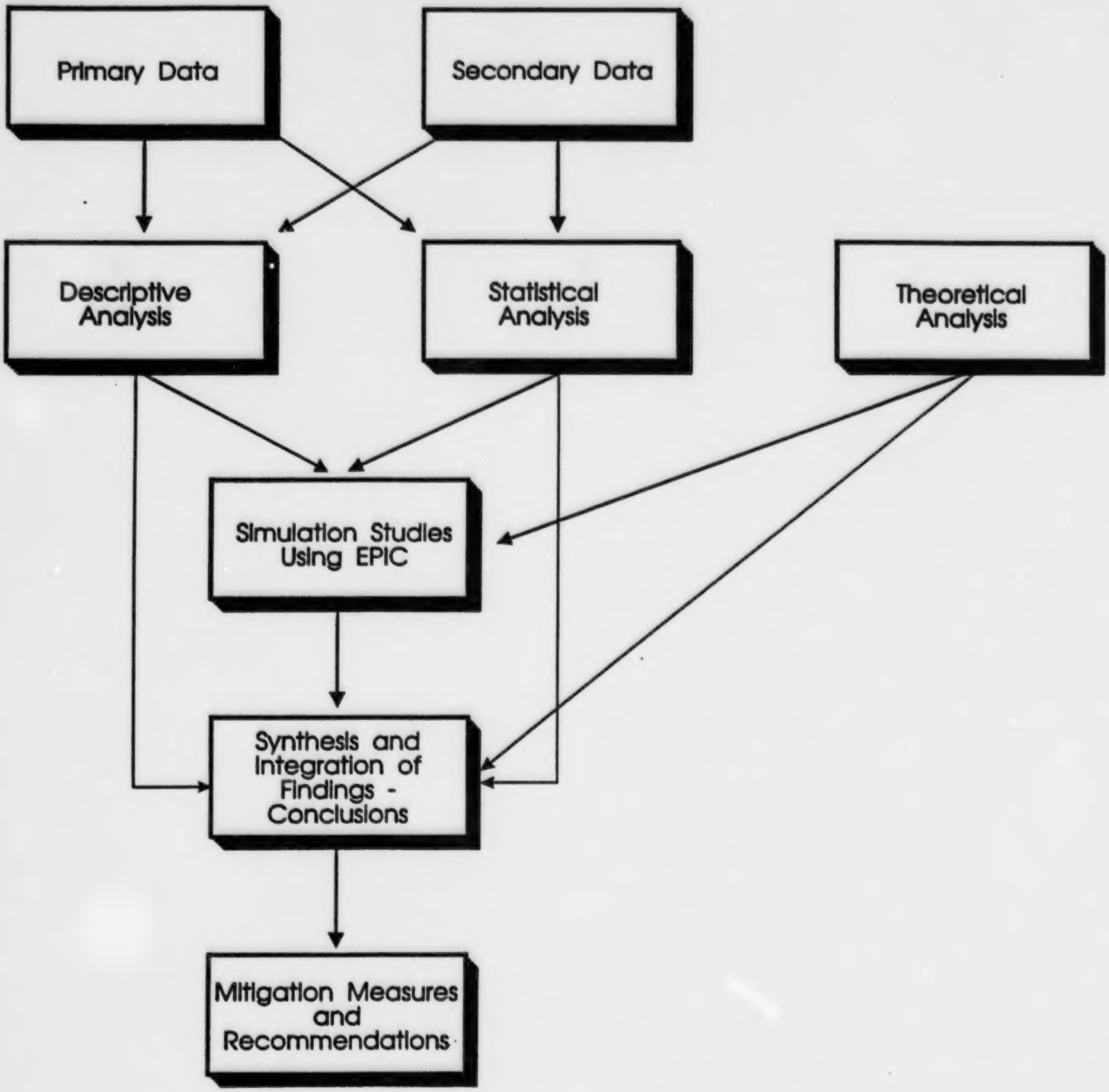
Primary Data
Secondary Data
Descriptive Analysis
Statistical Analysis
Theoretical Analysis
Simulation Studies Using EPIC
Synthesis and Integration of Findings - Conclusions
Mitigation Measures and Recommendations

FIGURE 3.1 ENVIRONMENTAL ASSESSMENT FRAMEWORK

environmental and economic impacts of GRIP on these biologically and agriculturally distinct regions within each province. Because GRIP operated differently among provinces, the primary level of analysis was soil regions within provinces, hereafter referred to as soil zones.

Primary and secondary data were analyzed with statistical and economic models to determine if land/input use practices changed as a result of GRIP (Figure 3.1). If the program was deemed responsible for land/input use changes, each change was assessed independently for its effect on the environment.

Characterizing identified impacts relied upon a set of impact definitions that were developed by the study team. These definitions were derived from impact assessment literature (e.g., Shopley and Fuggle 1984, Conover et al. 1985, CEARC 1988), coupled with the investigators' experience with other current impact assessments.

Definitions of impacts frequently involve the implications for biological populations (e.g., Conover et al. 1985) but these are inappropriate for assessing abiotic components of the environment (e.g., air quality, water quality, soil erosion). Therefore, customized definitions were required for this study. Given the diversity of environmental issues to be addressed and the fact that quantitative and qualitative methods were applied, a strong reliance was placed upon professional judgement in formulating these definitions. This is a common characteristic of environmental prediction approaches.

These definitions were established *a priori* (i.e., before the impact assessment occurred).

Scope

The scope of an impact relates to the geographical extent of that impact. For the purposes of this assessment, impact scope was confined to **Provincial** (an individual province) or **National** (the majority of or all provinces).

Duration

Impact duration relates to the period of time that the impact to the affected resource is detectable. For the purposes of this assessment, **Short-Term** refers to impacts which are manifested during a period of less than 10 years. **Long-Term** impacts are those that extend beyond 10 years and which may affect several generations.

Magnitude

Impact magnitude refers to the proportion of a population or resource affected by that impact. Duration of the impact also can influence magnitude.

A **Major** impact is defined as one that affects a resource base in a manner that jeopardizes the sustainability of that resource. In other words, the impact causes a decline or degradation in the resource beyond which natural events would not return that resource to its former level within several decades or generations (for abiotic environmental components 1 generation = 1 year). Major impacts can be manifested in the short and long-term. These impacts are readily detectable, have great ecological effects and are likely to generate intense public interest. Negative impacts are difficult to manage and also may be difficult to mitigate. Beyond the impact to the immediately affected resource, a major impact could occur if it compromises the resource user. Thus, for example, soil erosion which affects topsoil accumulation may also have adverse effects on the resource users' (farmer) ability to produce crops.

A **Moderate** impact affects the quality, abundance and/or distribution of the resource or users of that resource for one or more generations. Negative impacts may not compromise the long-term sustainability of the resource. Moderate impacts are detectable to the trained observer and may generate public interest. Negative impacts may be mitigated for fairly readily.

A **Minor** impact is one that affects only a small proportion of a resource. A minor impact is also one that will not adversely affect the long-term integrity of the resource. It is also unlikely to generate wide-spread public interest. Minor impacts are detectable only to the trained observer. Negative impacts can be prevented and mitigation measures, where required, should be readily attainable.

A **Negligible** impact is one that either is not detectable or for which a very small proportion of the resource is affected. At this level of detection, the changes to biota could be readily attributed to natural, random fluctuations in the environment.

The net effects of GRIP were calculated and examined for each province and overall environmental impact evaluations of GRIP were determined. In some instances, e.g., wetland loss due to GRIP, the net effect of the program on a particular environmental component might be deemed unacceptable. Hence, even if all net effects on the other environmental components are neutral, or even positive, the overall environmental impact would still be deemed negative. If the program was deemed to have negative environmental impacts, mitigative measures were recommended to alleviate the impacts.

3.2 DATA ACQUISITION

3.2.1 Primary Data

A mail survey was developed to assemble primary data on land and input use practices of GRIP participants before and after enrolment in the program. The mail survey asked program participants about their land and input uses in 1990 and 1992 (i.e., pre GRIP and post GRIP) in all provinces surveyed. If their land/input uses changed between the two time periods, the farmers were asked what influence GRIP had on the changes. Questions were broken into two components: crop insurance and revenue insurance. In this way, it was theoretically possible to discern whether one or both components influenced land/input use changes.

Farmers sampled in Saskatchewan were queried about their land and input uses in 1990, 1991 and 1992, because GRIP changed dramatically in that province between 1991 and 1992.

All provinces participating in the GRIP and/or NISA programs were sampled, except Quebec. As was discussed in the Introduction, the fundamental unit of stratification within each province was the major soil regions identified in Agriculture Canada's publication "Soils of Canada." In total, 16 sampling areas were established, 1 in British Columbia, 5 in Alberta, 4 in Saskatchewan, 3 in Manitoba, 2 in Ontario and 1 in the Atlantic Provinces.

Within each province, 600 farmers were sampled per soil zone stratum, except in the Atlantic Provinces. In all provinces/regions, farmers from 2 distinct groups were sampled per soil zone: those enrolled in both GRIP and NISA programs (n=450) and those enrolled in NISA but not GRIP (n=150). Sample frames for the 2 groups were then created by cross-referencing the GRIP and NISA data bases supplied by provincial and federal agencies. Within some soil zones (within certain provinces) all eligible farmers were sampled before the target number of 150 or 450 was reached. Consequently, the following number of farmers were sampled from each province:

	GRIP/NISA	NISA only	TOTAL
• British Columbia:	n = 235	n = 365	n = 600
• Alberta:	n = 2 250	n = 750	n = 3 000
• Saskatchewan:	n = 1 800	n = 600	n = 2 400
• Manitoba:	n = 1 316	n = 484	n = 1 800
• Ontario:	n = 900	n = 300	n = 1 200
• Atlantic Provinces:	n = 380	n = 217	n = 597
Total Sample Size	n = 6 881	n = 2716	n = 9 597

The sample size of at least 150 individuals per Soil Stratum x Farmer-group x Province category was chosen as a suitable compromise between statistical and budgetary constraints: large sample sizes were necessary to ensure statistical precision yet budgetary realities placed a ceiling on sample sizes.

The mail survey was designed to obtain information on land use and input use practices of Canadian farmers during the 1990 and 1992 farming seasons. These time periods were chosen to obtain data on farming practices before and after GRIP/NISA program initiation. Because the programs were initiated in the spring of 1991, we believed that many farmers would not fully understand the programs and thereby not have opportunity to alter their farming practices during that farming season. Thus, the 1991 farming season was omitted for all provinces except Saskatchewan. Inasmuch as the GRIP program in Saskatchewan changed dramatically from 1991 to 1992, the Saskatchewan questionnaire was designed to obtain information for the 1990, 1991 and 1992 farming seasons.

The questionnaires and cover letters were reviewed, revised and eventually approved by Agriculture Canada. A NISA questionnaire was developed for those participating in the NISA program but not GRIP and a GRIP/NISA questionnaire was developed for the participants of both programs.

The mail survey was designed and administered following the Total Design Method (Dillman 1978). All questionnaires were individually marked with large identification numbers in the upper left-hand corner of the inside cover. The identification number facilitated deletion of respondents from subsequent mailings, indicated their province of residence, the soil classification of their farm, and denoted whether he/she was enrolled in NISA only, or GRIP and NISA.

The mail survey utilized 4 separate personalized mailings over a 10 week period (Table 3.1). All mailings were dispatched through first-class mail. The initial mailing contained a questionnaire, personalized cover letter explaining the purpose of the survey, and a postage-paid return envelope. The second mailing, dispatched to all farmers 1 week after the initial mailing, consisted of a postcard reminder/thank you. The third mailing, dispatched to all nonrespondents 2 weeks after the second mailing, contained a new personalized cover letter, another copy of the questionnaire, and another postage-paid return envelope. The final mailing, dispatched to all nonrespondents 6 weeks after the third mailing, contained a new personalized cover letter, another copy of the questionnaire, and another postage-paid return envelope.

3.2.2 Secondary Data

Secondary data were acquired through information supplied by Statistics Canada, provincial crop insurance agencies and literature review. In addition to providing valuable information on land and input use trends before and after GRIP and NISA, this information provided indirect and independent information on how either program influenced land and input use.

The 1991 Agricultural Census data were used to discern the type and extent of seeded acreage that existed within each Prairie Province in 1991. This information was aggregated by soil zone and compared to the type and extent of seeded acreage that existed for GRIP participants in the Prairie Provinces acquired from Alberta, Saskatchewan, and Manitoba crop insurance agencies.

3.3 LAND/INPUT USE CHANGE

Land and input use capture most of the linkages to on-farm and off-farm environmental impacts of farming activities in Canada. Hence, the influence of GRIP and NISA on land and input use practices was the primary focus of this environmental assessment. As discussed above, the mail survey provided data on land and input use practices of GRIP and NISA participants before and after enrolment in the respective programs and allowed us to determine what influence, if any, each program had on land/input use.

TABLE 3.1

MAIL SURVEY ACTIVITY AND MAILING DATE OF ACTIVITY

ACTIVITY		DATE
First Mailing:	Cover letter and questionnaire sent to everyone in the survey via first class mail	16 November 1992
Second Mailing:	Reminder/thank you postcard sent first class to everyone	23 November 1992
Third Mailing:	New cover letter and another copy of questionnaire sent first class to nonrespondents	7-9 December 1992
Fourth Mailing:	New cover letter and another copy of questionnaire sent first class to nonrespondents	18-22 January 1993

It is important to note that the environmental assessment was contingent upon clearly identifying land/input use changes attributable to GRIP. Hence, prior to proceeding with the environmental assessment, one or more of the following null hypotheses had to be rejected:

H_1: Land use practices of GRIP participants did not change as a result of their enrolment in the program.

H_2: Input use practices of GRIP participants did not change as a result of their enrolment in the program.

Statistical and economic models were used to test these hypotheses.

The following sections of this chapter describe each component of the assessment framework, but do not incorporate any findings or results of the assessment (which are presented in subsequent chapters).

3.4 THEORETICAL ASSESSMENT

The first component of the assessment framework consisted of an examination of the details of the program in each province, and a conceptual or theoretical assessment of the influences the program was likely to have on farmers' decisions about crop selection and input use. The analysis included a discussion of the original, intended design of GRIP, referred to in the report as IGRIP, as well as discussions of the recognized problems of 'moral hazard' and 'adverse selection.' Each provincial version of GRIP was then compared and contrasted with IGRIP in order to determine how similar or dissimilar the farmer incentives were in that particular province.

3.5 DESCRIPTIVE ASSESSMENT

The second approach to answering the assessment questions was through descriptive summaries of both GRIP-related literature and information gathered through interviews, mail survey and written submissions. This component incorporated detailed summaries of written briefs submitted by interested individuals and organizations, a detailed analysis of the descriptive information obtained through interviews of resource professionals in each province, and some of the descriptive information gathered in the direct survey of a random sample of program participants in each province (except Quebec). The intention here was to provide a clear picture of perceptions of farmers and others regarding possible linkages between GRIP and the environment.

Fiscal and temporal constraints rendered a detailed assessment of the effect of GRIP on all environmental components unfeasible. Therefore, it was decided that the environmental assessment would focus on 2 major environmental components, soils and wildlife habitat.

Inasmuch as the major thrust of the environmental assessment was on the effects of GRIP-induced land and input use changes on soils and wildlife habitat, the survey questionnaire was structured accordingly. Hence, the soils and the wildlife assessments were driven by information obtained in the mail survey and subsequent economic modelling. The soils assessment was driven by simulation studies, whereas the wildlife assessment relied on information derived through a descriptive assessment.

The environmental acceptability of any land/input use changes brought about by GRIP was judged based upon predetermined environmental criteria. These criteria were region or soil zone specific. The wildlife criteria are discussed in depth below.

3.5.1 Wildlife

Today, wildlife professionals recognize the need to approach wildlife management from a holistic perspective. Species, including threatened or endangered ones, can only be preserved if their habitats are preserved. In essence, healthy habitats are necessary for healthy wildlife communities. However, the quantity and quality of wildlife habitat are declining in Canada. Lost or altered habitats, primarily in southern Canada, have reduced the abundance, diversity, and distribution of many indigenous species (Wildlife Minister's Council of Canada 1990). Thus, wildlife planners are attempting to ensure species diversity by developing habitat preservation goals for specific communities.

The basic tenet of wildlife management states that without habitat, there is no wildlife. Therefore, we focused our wildlife assessment on the effects of GRIP on the quality and quantity of wildlife habitat within each soil zone. A habitat-based assessment was necessary because fiscal and temporal constraints rendered species-specific assessments for individual soil zones impractical.

A Wildlife Policy for Canada, the national policy developed to provide a framework for federal, provincial, territorial and nongovernmental policies and programs that affect wildlife, states, "Governmental policies and legislation on resources and the environment and strategies for sustainable development should provide for conservation of wildlife and its habitats, and should ensure that all uses of resources are sustainable (Wildlife Minister's Council of Canada 1990:11)." The policy goes on to state (page 13), "*New technologies, policies, and laws--especially major macroeconomic, finance, and sectoral policies and laws that are likely to result in significant impacts on the environment--should also be assessed for their impacts on wildlife and biodiversity. Based on this analysis, governments should eliminate measures that favour overexploitation of biological resources or destruction of habitats.*" Therefore, according to this policy, GRIP should not encourage/influence the destruction of habitats, and a zero tolerance for habitat destruction is implied.

A Wildlife Policy for Canada defined wildlife as "all wild organisms and their habitats..." (Wildlife Minister's Council of Canada 1990). Our wildlife assessment focused on habitats, with the realization that all wild organisms are integral components of habitat.

Wildlife habitat can be divided into three broad habitat types: wetland, upland, and riparian (i.e., streamside). Hence, the impact of GRIP on these three habitat types was assessed within each soil zone. The questionnaire quantified if GRIP had caused the decline in any of these habitat types, and if so, at what magnitude. Then, based on habitat-specific assessment criteria (i.e., tolerance levels) established "*a priori*," an environmental impact evaluation was undertaken. Assessment criteria for the respective habitat types are presented below.

Wetland Habitat

Agriculture has been associated with the loss of 85% of Canada's wetlands (Wildlife Habitat Canada 1991). More specifically, agricultural development has been the major force in eliminating 68% of the wetlands in southern Ontario and 71% of the wetlands in the Prairie Provinces (Environment Canada 1986). In 1990, 30% of the existing wetland basins and 82% of the wetland margins in the Prairie Provinces were adversely impacted by farming activities such as clearing, drainage and cultivation (Caswell 1990). The World Wildlife Fund of Canada concluded in 1988 that the protection of the remaining wetlands in the Canadian Prairies was vitally important. However, *The Federal Policy on Wetland Conservation* (Government of Canada 1991*a*) recognises the value and importance of all wetlands in Canada, not just those located in the Prairie Provinces. Indeed, Wildlife Habitat Canada (1991:78) concluded, "Since wetlands are some of Canada's biologically richest habitats, they must be maintained across all landscapes."

The Federal Policy on Wetland Conservation outlines seven strategies for the use and management of wetlands in Canada. Strategy number two states, "The Federal Government will develop exemplary practices in support of wetland conservation and sustainable wetland use to be incorporated in the design and implementation of federal programs..." The Policy goes on to state that all federal departments should commit to the goal of no net loss of wetland function on federal land and waters and in areas affected by the implementation of federal programs where the continuing loss or degradation of wetlands has reached critical levels. The preceding paragraph leaves little doubt that wetland losses in agricultural landscapes across Canada have reached critical levels. Therefore, we invoked a zero tolerance level in assessing the impact of GRIP on wetland habitats in all strata. Hence, if GRIP caused loss of wetland habitat or function at any scale, the environmental impact was deemed negative and mitigation measures were required.

Upland Habitat

Conservationists across Canada agree that upland wildlife habitat must be preserved and enhanced within farmlands. For example, *The Status of Wildlife Habitat in Canada* (Wildlife Habitat Canada 1991) stated, "The farms of tomorrow should contain more, well connected areas of natural vegetation." Moreover, *The State of Canada's Environment* (Government of Canada 1991*b*) stated, "Wildlife habitat within agricultural areas must be conserved and enhanced to sustain a wide diversity of plant and animal species." Members of the agricultural sector also appreciate the need to conserve existing upland habitats within the agricultural landscape. For example, Ontario farmers recently published *Our Farm Environmental Agenda* (Ontario 1992), in which they recognized the need to preserve existing woodlots on the family farm. However, unlike wetland habitat, we could find no federal policy that specifically calls for the preservation of upland habitats on private lands. Nonetheless, *A Wildlife Policy for Canada* clearly states that governments should eliminate or modify policies that favour destruction of habitats. Inasmuch as upland habitats are indeed habitats, the wildlife policy can be interpreted to mean GRIP should not encourage destruction of upland habitats in any region of the country.

Upland Areas of Special Concern

The Canadian prairie ecosystems (grasslands and parklands) are located in the southern portions of Alberta, Saskatchewan, and Manitoba. These areas have been so radically transformed by human activity that they have become one of the most endangered natural regions in Canada. In fact, by the early 1980's, 70% of this region was under cultivation (Rowe and Coupland 1984). Today, little native prairie remains in a natural state, and what little remains is rapidly disappearing (World Wildlife Fund Canada 1989). For example, less than 1% of the original tall-grass prairie, 18% of the shortgrass prairie, 24% of the mixed grass prairie, and 25% of the aspen parkland remains (Gauthier and Henry 1989). Therefore, these habitats and their associated wildlife communities are of special concern (Wildlife Habitat Canada 1991).

Several organizations have stated that the loss of habitat is the most critical issue facing prairie wildlife today (e.g., Gauthier and Henry 1989). Moreover, (1) relative to its area, a disproportionate number of threatened and endangered wildlife species live in the prairie ecosystems (Burnett et al. 1989), (2) the multinational North American Waterfowl Management Plan calls for the maintenance and enhancement of upland waterfowl nesting habitat within the Prairie Provinces; and (3) the Prairie Conservation Action Plan (World Wildlife Fund Canada 1989) calls for the conservation of all existing native prairie and states that all federal and provincial governments should revise their policies and legislation to encourage conservation of habitat. Hence, it seems protection of the remaining Prairie habitats is vitally important to Canada's wildlife.

Based on this compelling evidence for the need to conserve remaining natural habitats within the Prairie Provinces, we invoked a zero tolerance level for GRIP-related upland habitat loss within the prairie soil strata. Hence, if GRIP caused upland habitat loss at any scale within the Prairies, the environmental impact was deemed negative and mitigation measures were required.

Outside the prairie soil strata, e.g., in British Columbia, Ontario, and the Atlantic Provinces, private and governmental conservationists were contacted to establish tolerance levels (if they existed) for upland habitat loss. None of the individuals that were contacted in these provinces expressed concern over upland habitat loss in agrarian settings. Hence, no "*a priori*" tolerance levels were established for these areas.

Riparian Habitat

Riparian zones are bands of vegetation associated with stream/river banks. Plants within riparian zones generally require greater soil moistures than would be found in adjacent uplands. Hence, riparian zones usually create well-defined habitat zones within drier surrounding areas. While riparian zones usually include a minor proportion of the overall landscape, they are more productive in terms of plant and animal biomass than the overall landscape and are a critical source of biotic diversity within the ecoregion (Thomas et al. 1979). Johnson et al. (1977) concluded riparian habitats were the most productive and possibly the most sensitive habitats in North America.

The State of Canada's Environment (Government of Canada 1991*b*) stated that riparian habitats within the Prairies are threatened. Inasmuch as all riparian zones within the Prairies are integral components of the prairie ecosystems, they should also receive the level of protection afforded to the upland areas discussed above. Therefore, within the prairie soil zones, a zero tolerance for riparian habitat loss was invoked for the environmental assessment. If GRIP caused riparian habitat loss at any scale within the Prairies, the environmental impact was deemed negative and mitigation measures were required.

The Status of Wildlife Habitat in Canada (Wildlife Habitat Canada 1991) concluded that regulations for the conservation of wetlands should also include protection of all riparian zones in Canada. However, we could find no federal policy that specifically called for the protection of riparian zones. Therefore, outside the prairie soil strata, e.g., in British Columbia, Ontario, and the Atlantic Provinces, private and governmental conservationists were contacted to establish tolerance levels (if they existed) for riparian habitat loss. None of the individuals that were contacted in these provinces expressed concern over riparian habitat loss in agrarian settings. Hence, no "*a priori*" tolerance levels were established for these areas.

3.6 STATISTICAL ASSESSMENT

Data collected via the survey and from secondary data sources were statistically analyzed with the specific objective of finding out whether land use, input use and management differed in a statistically significant way after the introduction of GRIP, compared with the years preceding introduction of the program.

3.7 SIMULATION STUDIES USING EPIC

The objective of this assessment was to determine whether potential changes in soil productivity and nonpoint source pollution (NPSP) risk resulting from changes in farming practices as a consequence of GRIP existed. To aid in the assessment, the computer simulation model EPIC (Erosion-Productivity Impact Calculator) was applied to the 17 reporting areas identified in Section 3.2.1. EPIC consisted of: (a) physically based components for simulating erosion (wind and water), plant growth, and related processes; and (b) economic components both for assessing the cost of erosion and for determining optimal management strategies. The model was designed to aid in decision-making, ranging in scope from farm-level to national-level decisions and is capable of examining drainage, irrigation, water yield, erosion control, weather, fertilizer and lime applications pest control, planting dates, tillage, and crop residue management (Sharpley and Williams 1990). The model has been applied extensively in the United States as well as in France (Cabalguenne et al. 1990) and in Alberta from a model evaluation perspective (Izaurralde et al. 1992). It has also been applied to policy evaluation (Lerohl 1991). While the model has extensive capabilities, our focus was on soil erosion (wind and water) and soil quality (organic content), and the related on-farm economic consequences of various soil degradation scenarios.

The EPIC Simulations

The use of EPIC for the assessment of the environmental impacts of policy and programming in the context of sustainable agriculture was fully warranted. In fact, we would argue that it is at present one of the few legitimate tools for such assessment. The alternative was to estimate environmental impacts in terms of rates of eroded soil thickness, or some other measure of immediate environmental degradation such as destruction of wetland habitat or loss of biodiversity, without any reference to the ecosystem's resiliency. In the case of soil erosion rates, "tolerable rates of soil erosion", or *T-values*, have been developed. These values are meant to represent the rate of topsoil (Ah horizon) regeneration, and thus indirectly, the rate at which this topsoil can be removed through erosion without adversely affecting soil productivity. This approach to the assessment of the impact of soil erosion on soil productivity is unreliable in the sense that the accuracy of T-values cannot be tested scientifically. That is, because of the geological time-frames involved, validation and calibration data for models of topsoil regeneration cannot be obtained directly. This makes the verification of the T-value hypothesis impossible. On the other hand, the impact of topsoil removal on soil productivity can be modeled and, more importantly, simulated through the physical removal of regular increments of topsoil in controlled field experiments. This allowed for the testing of modelling hypotheses and the ultimate development of a valid analytical, descriptive and predictive tool. This was the rationale for the development and use of EPIC.

EPIC can generate estimates of soil productivity and NPSP risk estimates such as crop and biomass yield, and nutrient discharges through surface runoff and percolation in response to eroded soil thickness over time for various land uses and farming systems. If these response curves indicate that soil productivity and NPSP can be maintained beyond a set simulation period, 400 simulation years for instance, it can be inferred that the particular farming-system or land use is not an immediate threat to sustained soil productivity. If not, then we would recommend that further increases in soil erosion be prevented if sustainable agriculture is to be assured in that reporting area.

EPIC is essentially designed to simulate the long-term response of soil productivity to soil erosion at the field or quarter section level. Our use of the model, to infer cumulative regional impacts over millions of hectares, was thus subject to qualification. The cumulative impacts that we reported were not regional averages but rather average impacts on representative farms and soils under prevalent land uses and farming systems in that reporting area. The reported environmental impacts were weighted averages, taking into consideration both the change in the areal extent of prevalent land use scenarios and the long-term simulated impact of these scenarios on eroded soil thickness.

As an indicator of the long-term impacts of these rates of erosion on soil productivity and NPSP abatement, we simulated their impacts over a 400 simulation year period. This was equivalent to 200 iterations of the EPIC datasets describing any one, 2-year rotation. If the EPIC-generated rates of erosion did not demonstrate in that simulation period an ability to destroy the inherent soil productivity and NPSP buffering capacity, then we inferred that they do not represent an immediate threat to sustainable agriculture and that increases in soil erosion rates, attributable to GRIP or NISA for instance, could be endured.

Estimation of Environmental Impacts

The Seven Prevalent Land Uses and Farming-Systems

To obtain the EPIC-generated rates of soil erosion, we had to construct a number of datasets representative of the prevalent land uses and farming systems in 17 reporting areas (reporting areas were synonymous with sampling strata for all provinces/regions except the Atlantic Provinces, which were further divided into C2 and D2 soil zones for the EPIC analyses). Based on the survey results, we were capable of identifying seven such land uses which encompassed most of the agricultural activity in these areas. These included:

50/50 cultivated summerfallow/cereal cropping in the Prairies. This farming system is considered conventional and its use is widespread. Environmental impacts associated with this scenario are considered negative to the extent that they contribute to increased wind and water induced soil erosion in the Prairie Provinces and increased water erosion of soil and NPSP in the sub-humid regions of the country.

Continuous cropping of cereals and corn. The impact of cultivated summerfallow can also be altered by a shift to continuous cropping of cereals. The prevalence of this land use can be seen as inversely proportional to the prevalence of the previous land use. Because of the continued presence of stubble, the incidence of water and wind-induced soil erosion is reduced and the sustainability of cropping is increased. Continuous cropping of corn, however, is likely to have negative consequences on soil productivity and NPSP risk.

Chemfallow of wheat in the Prairies. As an intermediate alternative to cultivated summerfallow and zerotillage, chemfallow is a means of increasing the sustainability of cropping in the Prairie Provinces. Though it is less risky agronomically than continuous cropping (i.e., the risk of crop failure due to inadequate soil moisture is less), its "chemical dependency" (for weed control) is a source of NPSP risk.

Zerotillage of wheat in the Prairies and the Atlantic Provinces, and zerotillage of corn in Ontario. Zerotillage has the potential to increase the soil organic content of the soil, as well as to reduce the severity of water and wind-induced soil erosion. Because of its greater dependency on chemical weed control and increased fertilizer requirements, zerotillage also can increase agricultural NPSP risk.

Perennial Forages. Perennial forages include alfalfa and clovers grown and mechanically harvested for cattle feed. The rates of soil erosion under such a land use is substantially less than under annual cropping. Perennial forages are also considered a nitrogen benefit to the soil. Perennial here refers to crops lasting more than 2 or 3 years. The plow-down year, though it involves cultivation and soil disturbance, can be seen as a form of green-manuring.

Pasture. Pasture here includes improved, seeded pasture, as opposed to unimproved pasture or range. Conceptually, pasture land here encompasses Permanent Cover Program (PCP) land, that is, marginal land which would otherwise be under annual cultivation.

Rangeland. Rangeland here includes both grazed and ungrazed grassland as well as woodlands and shrub accessible to cattle. Unfortunately, this category is an aggregate of upland woodland and shrub and riparian woodland and shrub. The grazing of riparian areas being of far greater environmental consequence than the grazing of upland areas.

EPIC was well suited to the simulation of the long-term impact on soil productivity and NPSP risk of various land uses. The long-term averages in biomass and crop yields (as indices of soil productivity), and in the lateral and downward movement through the soil column of nitrates and phosphates (as indices of NPSP risk), generated by EPIC can be used to infer the environmental impacts of GRIP and NISA induced land use changes. We also calculated estimates of the decrease in soil organic matter (%) over time as an index of soil physical quality and fertility (especially cation exchange capacity (CEC)) (data not reported).

The cumulative impact of GRIP on the environment was calculated by adding the estimated rates of soil erosion associated with each of the above land uses weighted for the areal extent of these land uses before (1990) and after (1992) the program. Because some of these impacts may be negative while others may be positive, the overall impact may be negligible. The resulting indices will be estimates of the environmental impacts in terms of average eroded soil thickness in that reporting area attributable to land use changes under GRIP.

Land Use Diversity Indices (LUDIs)

According to Merriam et al. (1993), in order to assess the degree to which the spatial configuration of the vegetation mosaic influences ecosystem processes, methods for quantifying the spatial character of the landscape are required. There are apparently two complementary ways to quantify the landscape mosaic: 1) measuring characteristics of the individual component patches, and 2) using indices that describe the relationships between the patches for the whole landscape. The spatial patterning of ecosystem types is a unique new phenomenon that arises at the landscape level (Klopateck et al. 1983). The problem, therefore, is to detect and quantify pattern in the spatial heterogeneity of landscapes (O'Niell et al. 1988).

Land use diversity indices (LUDI) were calculated using the survey data. LUDIs were an adaptation of the Shannon-Wiener Function (Krebs 1989). Strictly speaking, the Shannon-Wiener function should be used only on random samples drawn from large communities in which the total number of species is known. To obtain this information we used both, Statistics Canada's Census of Agriculture data on a provincial basis, and the actual survey results on a reporting area basis. Changes in land use diversity was inferred if the provincially based LUDI changed dramatically from the 1986 to the 1991 census period. Changes in land use diversity also was inferred if the LUDI based on reporting areas changed from 1990 to 1992.

Land use diversity indices (LUDI) were calculated as follows:

$$\mathbf{LUDI = \Sigma\ p_i * ln(p_i)}$$

where **p** is the percentage of the reporting area or province occupied by crop species or land use *i*. On a provincial basis *i* included all various grains and oilseeds, whereas on a reporting area basis grains and oilseeds were aggregated.

3.8 SYNTHESIS AND INTEGRATION OF FINDINGS

The environmental assessment framework adopted for this assessment included several lines of investigation. The use of descriptive, statistical and theoretical approaches was dictated by the availability of data to address the various environmental issues of concern. Not surprisingly then, the potential existed for inconsistencies in conclusions reached.

The various investigators associated with the study team convened amongst themselves and with Agriculture Canada representatives to discuss the strengths and weaknesses of the data bases used to draw conclusions and the robustness of the conclusions. The participants concluded that where inconsistencies occurred, that the greatest degree of confidence would be associated with conclusions derived from the quantitative analysis of the survey data, and the statistical analysis of the census and other secondary data. The conclusions derived from the conceptual and theoretical description of GRIP, and the opinions expressed in either the written submissions or the cross-Canada interviews were considered to warrant the least emphasis. Conclusions from the simulation studies using EPIC to evaluate soil erosion and non-point source pollution were deemed to lie somewhere in between. Hence, where inconsistencies or conflicts in conclusions arose, we relied upon the conclusions generated by the evidence derived from the farmer surveys.

3.9 MITIGATION MEASURES

Once the extent and significance of the environmental impacts of GRIP in each soil zone and province were known, it was possible to begin to think about mitigation measures. Two principal types of measures were investigated, namely, measures involving modifications to GRIP in individual provinces, and other types of measures not associated directly with the program such as enhanced or expanded soil conservation or habitat protection programs.

The examination of program modifications included a special study of the feasibility and appropriateness of environmental compliance measures ("cross-compliance") such as those that have been implemented in the United States under the Food Security Act (FSA 1985) and the Food Agriculture Conservation and Trade Act (FACTA 1990). These include requirements that farmers implement approved soil conservation farm plans if they cultivate highly erodible lands, or risk loss of eligibility for program benefits under a broad range of farm programs. Prohibitions against draining wetlands ("swampbuster") and against bringing formerly uncultivated marginal lands into cultivation ("sodbuster") are other features of the U.S. farm legislation that we wanted to assess from a Canadian perspective.

As explained in chapter one and in the Terms of Reference for this study, the Federal-Provincial GRIP Agreement calls for the definition of the "circumstances and conditions under which insurance may be withheld, restricted or enhanced, for the purpose of protecting the environment". Similar requirements are included under the crop insurance and NISA agreements, consistent with Section 5(2)(a) of the Farm Income Protection Act. Consequently, a special effort was made to identify and assess what those "circumstances and conditions" might be, and to propose an approach to implementation that would be most likely to win support from both farmers and environmental interest groups.

4.0 THEORETICAL AND CONCEPTUAL ASSESSMENT

4.1 INTRODUCTION

The private viability and public desirability of agricultural insurance is the subject of a growing debate (Crerar 1991). The basic problems of viability, whether offered by the private or public sectors, are associated with moral hazard and adverse selection. The problem with moral hazard is that the farmer may adopt more risky or less productive practices when insured. The problem of adverse selection is that the premium rate structures may not be sufficiently tailored to individual farmers so that only the farmers more apt to take risks or less productive farmers will find participation attractive. These principle-agent problems of insurance have been clearly defined by Arrow (1984), Spence and Zeckhauser (1971), and by Rothschild and Stiglitz (1976). Nelson and Loehman (1987) and, subsequently, Chambers (1989) have demonstrated their applicability to agriculture theoretically in a general manner, but little empirical evidence has been presented for agricultural insurance.

Insurance has been an increasingly important component of agricultural policy in many countries including the United States and Canada. These programs have been heavily subsidized. In the United States, most crop insurance premiums are heavily subsidized by government (30 percent in most cases during the 1980's and somewhat less under the 1990 farm bill); in addition, the government reinsures private companies and incurs heavy administrative costs. In Canada, the federal-provincial governments pay one-half of farmer premiums and all of the administrative costs. In spite of these subsidies, crop insurance participation varies widely among regions, with heavy participation mainly in the Northern Plains of the U.S. and in the southwestern Canadian Prairies, where rainfall is low and yields are relatively more variable. Some important issues are whether the problems of moral hazard and adverse selection explain the poor performance and participation of the programs and whether these problems can be partially mitigated by better program design.

4.2. IMPLICATIONS TO PROVINCIAL GRIP PROGRAMS

When the target revenue exceeds the expected market revenue or approaches the maximum revenue that a farmer could anticipate from growing the crop, the IGRIP will have a bearing upon which crop is seeded. Fear of distortions in crop selection under GRIP has been labelled "adverse crop selection", and should not be confused with the common problem of adverse selection under most crop insurance programs. Annual premiums increase whenever the target revenue is anticipated to exceed expected market revenue. However, with only one-third of the premium cost paid by farmers, this cost alone is unlikely to discourage increased production of a crop. Switching crops may have an environmental impact if the crops use different tillage systems, pesticides and fertilizer. Target revenues have more year to year stability than expected market revenues. If crops occupy a larger or smaller share of the land base because of revenue insurance they will tend to retain this share longer than when year to year changes in market prices and sales have more influence upon crop selection. Whether a wider range of crops in terms of species types will be grown in the context of revenue insurance depends upon the relative relationship of their target revenues, premiums, production costs and market revenues. In the context of crop selection under GRIP, one potential consequence could be loss in diversity in land use as more and more of the cultivated land base is allocated to a few dominant crops.

Problems associated with detecting moral hazard when it involves reduced input usage require monitoring, including inspections and verification of farming practices, as is already the case under crop insurance. The added costs for these controls may mean that the moral hazard issue is not always detected. Environmental impacts of moral hazard type decisions involve increased planting of crops qualifying for GRIP and less summerfallow, fertilizer and pesticide usage. Some of the transitional provisions introduced in the provincial GRIP programs were to counter the moral hazard and adverse crop selection problems associated with IGRIP. Concerns over accurate individual yield coverage and the impact of full yield offsets were attempts to reduce the probability that farmers would reduce their use of inputs. Farmers in the provinces of Alberta and British Columbia are able to choose a probable yield higher than their assigned coverage by paying the associated increase in premium. The benefit is that any market revenue received by production exceeding the assigned coverage but below the probable yield was retained by the farmer. Therefore, marginal net income between the assigned yield level and the probable yield is nearly identical to the circumstance with no insurance. The only difference is the added marginal cost of the offset premium. Prince Edward Island introduced offset protection to discourage moral hazard but a farmer's annual yield must exceed the area average to receive the full benefit. This program is similar to superior management adjustment (SMA) in Manitoba. A farmer's coverage level is raised retroactively for the year in question if the recorded crop yield exceeded the area average in that year by more than five percent. Therefore, if a farmer believes that his crop yields will exceed those of his neighbours he will continue to use higher levels of inputs or expand their utilization. The incentive is greater in Manitoba than the other provinces offering offset provisions because the higher adjusted yield receives the IMAP price level. Ontario chose to ignore the offset provision entirely. Instead, the GRIP premium was targeted to price insurance not revenue insurance. If the market price fell below eighty percent times the IMAP price the GRIP indemnity equalled the price difference times eighty percent of the LTAY. Therefore, moral hazard in terms of marginal revenue of input use did not change with the GRIP program in Ontario. However, with the reduced price risk, a crop's expected average revenue increases and risk averse farmers will have a tendency to increase input usage relative to previous stabilization programs which were less predictable.

Acreage limits were included in the Alberta, Saskatchewan and Manitoba programs in an attempt to reduce the land which could be seeded to GRIP eligible cereal grain crops. No upper limits were imposed for specific crops, except that Saskatchewan prevented more than twenty percent of the eligible areas in special crops. In each of the Prairie Provinces an upper limit of ten percent increase in eligible crops was an attempt to restrict the reduction in summerfallow and ploughing of hay and pasture land. Quebec has upper limits for each farm and specific limits of 1000 acres for corn, soybeans and cereal grain crops.

The expected effect of the Jackson offset is to increase input usage relative to IGRIP. Revenue from crop yields exceeding the IGRIP coverage level does not increase a farmer's income until crop market receipts exceed the AGRIP revenue guarantee. The Jackson offset allows a farmer to retain total crop receipts above the IGRIP target revenue until the Jackson yield is attained. Therefore, at the margin, the Jackson offset is neutral with respect to the added unit of input used because the farmer receives the same marginal revenue as if revenue insurance was not available. Although the marginal expected revenue does not differ for crop yields between the IGRIP target revenue and the Jackson offset yield, the average revenue is much higher. Farmers have the security of realizing at least the target revenue and, therefore, the financial risk of using more operating inputs (fertilizer and pesticides) is reduced. Risk averse individuals will increase their income through using more operating inputs with the Jackson offset in concert with IGRIP. Therefore, Alberta and British Columbia fertilizer and pesticide sales should both have increased and the area summerfallowed decreased.

New Brunswick, Nova Scotia and the 1991 GRIP program in Saskatchewan operated very close to the intended GRIP (IGRIP). They had the greatest potential for moral hazard because there were no special provisions to adjust the level of yield coverage. Saskatchewan 1992 GRIP program minimized moral hazard because it shifted revenue insurance to price insurance. Like the Ontario GRIP program, the 1992 Saskatchewan program was basically a price deficiency program but the deficiency payment was based upon the composition of crops grown in the area, not the specific crop. By basing the deficiency payment on a basket of GRIP eligible crops, the 1992 Saskatchewan program was neutral with respect to selecting which GRIP eligible crop to grow, but had a built in incentive not to produce crops outside of GRIP. The 1992 Saskatchewan GRIP ranked highest in terms of minimizing moral hazard, and neutrality with respect to production and marketing decisions. This was followed by Quebec GRIP with comparable moral hazard but less neutral in terms of crop selection. Moral hazard was minimized in Ontario GRIP. But, because the IMAP prices were the basis for determining each crop's annual GRIP indemnity, these potential payouts introduced a non-neutral incentive in terms of which crops were produced. In the case of Alberta farmers electing the Jackson offset, the problem of moral hazard was reduced, but was present for those not choosing this option. Similarly, in Manitoba the SMA adjustment was retroactive, but farmers had to choose whether they believed the cost of attaining higher yields would be rewarded through potentially higher GRIP indemnities. Some chose to reduce inputs and accept the IGRIP payouts, while others aimed for higher GRIP indemnities by using more inputs. Because GRIP indemnities were crop specific in Manitoba, the program had a bearing on crop selection.

In 1991 and 1992, all the GRIP contracts increased the expected revenue from nearly all the eligible crops because the target revenues exceeded expected market revenues with no insurance or historical stabilization programs. Because GRIP was more predictable than

NISA or other past stabilization programs, the probability of an indemnity payment was factored more readily into a farmer's crop production decision. This had the effect of increasing the expected revenue from all eligible crops as well as reducing the variability of annual returns. The long-term net effect will likely result in increased input usage and adopting crop management strategies which will tend to be more risky than if a less predictable income stabilization program was followed.

5.0 DESCRIPTIVE ASSESSMENT

5.1 INTRODUCTION

The descriptive assessment component of the analyses incorporated detailed summaries of written briefs submitted by interested individuals and organizations, summaries of information obtained through interviews of resource professionals in each province, summaries of land use information obtained from Statistics Canada and the provincial crop insurance agencies, and descriptive summaries of information gathered in the survey of program participants in each province (except Quebec). The intention of the descriptive analyses was to provide a clear picture of perceptions of farmers and others regarding possible linkages between GRIP and the environment.

5.2 PRIMARY INFORMATION

5.2.1 Written Briefs

Twenty five written briefs were received from individuals and organizations across Canada. A summary of the environmental issues included in the written briefs is provided in Figure 5.2.1.

5.2.2 Interviews With Resource Personnel

As was discussed in section 2.2, interviews were held with private and public agricultural and environmental resource personnel from across Canada. A summary of the environmental issues they identified is provided in Figure 5.2.2.

5.2.3 Mail Survey

Response rates to the mail survey were good. The overall response rate for farmers receiving the GRIP/NISA questionnaire was 64%, ranging from a high of 74% in Ontario to a low of 58% in Saskatchewan (Table 5.2.3.1).

Because FIPA and the Federal-Provincial Crop Insurance Agreement require a separate environmental review of crop insurance, our assessment of areal changes in land use focused on revenue insurance. Nonetheless, we provided information on the proportions of producers that were influenced by crop insurance as well. Tables 5.2.3.2 and 5.2.3.3 summarize the impacts of revenue and crop insurance, respectively, on land use and input decisions of farmers across Canada. Impacts are summarized as positive (+), negative (-) and neutral (0). The magnitude of these impacts is discussed in section 8.

FIGURE 5.2.1

ENVIRONMENTAL ISSUES RELATED TO GRIP BASED ON WRITTEN SUBMISSIONS

Organization/Individual	Largely No Effect	Adverse Selc'n - Erosion	Maximize Prod'n with Envir. Conseq's	Crop Marginal Land	Degrade Wildlife Habitat	Degrade Wetlands	Discourage Diversif.	Pestic./Fertil. Contam.	Moral Haz. Fertil.	No Conserv. Incentive	Excludes Forages	Discourage Rotations	Discourage Flex Cropping	Stable Income Allows Conservation	Less Summer-Fallow
• Manitoba N.W. Soil Mgmt. Assoc.	✓														✓
• Manitoba Farmer		✓													
• Manitoba Organic Producers Assoc.								✓		✓		✓			
• Manitoba Institute of Agrol.				✓						✓		✓			
• Ontario Corn Producers	✓														
• Ontario Institute of Agrol.	✓	✓													
• Alberta Farmer	✓														
• Alberta Farmer			✓	✓	✓	✓									
• Alberta Farmer			✓												
• Sustain. Agri. Assoc. Alta.	✓														
• Alberta Conserv. Till. Soc.									✓				✓	✓	
• Alberta Pool		✓										✓		✓	
• Sask. Wheat Pool							✓		✓	✓					
• Sask. Organic Farmer										✓		✓			
• Back to Farm Res. Instit.			✓					✓							
• Sask. Wetland Conserv. Corp.			✓	✓	✓	✓				✓					
• Sask. Soil Conserv. Soc.			✓	✓							✓				✓
• Sask. Envir. Society			✓	✓			✓		✓	✓	✓				
• Can. Fertilizer Instit.	✓														
• Dryland Salinity Control Assoc.				✓			✓				✓		✓		
• West. Barley Growers Assoc.				✓					✓					✓	
• Brewing & Malting Barley Res. Inst.	✓														
• Ducks Unlimited Canada			✓	✓		✓					✓				
• Nature Conservancy Canada										✓					

FIGURE 5.2.2

ENVIRONMENTAL ASSESSMENT ISSUES ASSOCIATED WITH GRIP BY CANADIAN PROVINCE •

Environmental Component	Alberta	Atlantic Provinces	British Columbia	Manitoba	Ontario	Saskatchewan
LAND USE						
· Marginal Lands	*		*	*	*	*
· Crop Mix	*	*	*	*	*	
· Failure to Cover Forages	*	*	*	*	*	*
· Cultural Practices	*		*	*	*	*
SOILS						
· Organic Matter Loss	*		*	*	*	*
· Water/Wind Erosion	*	*	*	*	*	*
FERTILIZER/PESTICIDE INPUTS	*				*	*
WILDLIFE HABITAT	*	*	*	*		*
WATER QUALITY/FISHERIES	*	*	*		*	*
AIR QUALITY	*					*

• Presence of "*" indicates that one or more interviewees from the province identified the environmental component as a potential issue.

TABLE 5.2.3.1

MAIL SURVEY RESULTS FOR THE GRIP/NISA QUESTIONNAIRE

PROVINCE	TOTAL SAMPLED (n)	RESPONDENTS (n)	NON-RESPONDENTS (n)	REFUSALS (n)	UNDELIVERABLE (n)	DECEASED (n)	% RESPONSE[a]
British Columbia (1)[b]	235	136	88	7	4	-	59%
Alberta (5)	2250	1447	742	49	10	2	65%
Saskatchewan (4)	1800	1048	668	78	4	2	58%
Manitoba (3)	1316	879	407	27	2	1	67%
Ontario (2)	900	661	219	17	3	-	74%
Atlantic Provinces (1)	380	233	134	10	3	-	62%
TOTAL (16)	6881	4404	2258	188	26	5	64%

[a] % Response = (Respondents) ÷ (Total Sampled - [Undeliverable + Deceased]) x 100

[b] Number of soil zones sampled within the province.

TABLE 5.2.3.2

SUMMARY OF THE ESTIMATED[1] IMPACTS OF THE 1992 REVENUE INSURANCE PROGRAM ON FARMING PRACTICES AND LAND USE DECISIONS

	B.C.	Alberta					Saskatchewan				Manitoba			Ontario		PEI	NS	NB
	C2	A1	A2	A3	B's	C2	A1	A2	A3	C2	A3	A4	C2	C1	E1			
Crop Selection	-[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fertilizers	+	+	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-
Herbicides	-	-	-	-	-	-	o	o	+	+	-	o	o	o	-	-	-	-
Perennial Forages	+	+	+	+	o	+	+	+	+	+	+	-	o	o	+	+	+	+
Tillage Practices	+	o	+	+	+	+	+	+	+	+	-	+	+	+	+	+	o	+
Summerfallow Acreage	+	-	+	+	+	+	-	-	+	+	+	+	+					
Summerfallow Cultivation[3]	o	o	o	+	o	o	o	o	o	+	o	o	o					
Riparian Zones	o	o	o	-	-	+	o	o	+	o	o	-	o	+	+	+	o	+
Field Margins	-	o	o	-	-	+	+	o	-	o	-	+	o	o	-	-	o	-
Wetland Margins	-	o	o	o	+	-	o	o	o	o	o	o	o	+	o	+	o	o
Wetland Drainage	-	o	o	-	-	-	o	o	o	-	o	-	-	-	o	-	o	-

[1] Estimates derived from mail survey.

[2] o = program was neutral; (-) = program had a negative influence; (+) = program had a positive influence

[3] Farmers who indicated that they were influenced by the program identified GRIP, but did not distinguish between revenue and crop insurance.

TABLE 5.2.3.3

SUMMARY OF THE ESTIMATED[1] IMPACTS OF THE 1992 CROP INSURANCE PROGRAM ON FARMING PRACTICES AND LAND USE DECISIONS

	B.C.	Alberta					Saskatchewan				Manitoba			Ontario		PEI	NS	NB
	C2	A1	A2	A3	B's	C2	A1	A2	A3	C2	A3	A4	C2	C1	E1			
Crop Selection	-[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fertilizers	-	+	+	o	-	-	-	+	+	-	-	-	o	-	-	-	-	-
Herbicides	-	-	-	-	-	+	+	+	+	-	-	-	o	-	+	-	-	-
Perennial Forages	+	+	+	+	+	+	-	+	+	+	+	o	o	o	+	+	+	+
Tillage Practices	o	o	+	+	+	+	o	+	+	+	o	-	+	+	+	-	o	o
Summerfallow Acreage	+	+	+	+	+	+	-	+	+	+	+	+	+					
Summerfallow Cultivation[3]	o	o	o	+	o	o	o	o	o	+	o	o	o					
Riparian Zones	o	o	o	-	o	+	o	-	+	o	o	-	o	+	+	o	o	+
Field Margins	o	o	o	-	-	+	+	o	-	o	-	+	o	-	-	o	o	-
Wetland Margins	o	o	o	o	+	o	o	o	o	o	o	o	o	+	o	+	o	o
Wetland Drainage	-	o	o	-	-	-	o	-	o	o	o	o	-	-	o	-	-	o

[1] Estimates derived from mail survey.

[2] o = program was neutral; (-) = program had a negative influence; (+) = program had a positive influence

[3] Farmers who indicated that they were influenced by the program identified GRIP, but did not distinguish between revenue and crop insurance.

Crop Selection

Crop selection toward more of a monoculture setting was considered to have a negative environmental effect based on reduced diversity.

The revenue insurance component of GRIP, influenced crop selection toward GRIP-eligible crops in all provinces and study areas. From 13% to 25% of the farmers in the respective provinces indicated that they were influenced by the revenue insurance component of GRIP to decrease the diversity of their crops. However, the majority (75%) of Canadian farmers were not influenced by GRIP to change their crop selection. Overall, GRIP was considered to have a negative environmental impact based on reduced crop diversity.

Fertilizer Use

An increase in fertilizer use was considered to be a potentially negative impact from the perspective of potential increases in non-point source pollution.

Overall, revenue insurance influenced more farmers to increase their fertilizer inputs than to decrease them (9 of 16 study areas). In the other 7 study areas, the reverse occurred, with more farmers being influenced to decrease their fertilizer inputs than doing otherwise. However, less than 9% of the producers in any given soil zone indicated that revenue insurance influenced them to change their fertilizer inputs in 1992 from that which occurred in 1990. Therefore, it appeared that GRIP has a slightly negative impact as evinced by a net increase in fertilizer use in over half of the study areas.

Herbicides

Like fertilizer utilization, increases in herbicide use were considered to have potentially negative impacts based upon contributions to non-point source pollution.

Overall, revenue insurance influenced more farms to increase their herbicide inputs than to decrease them (9 of 16 study areas). However, in any given soil zone or Province, at least 90% of the farmers indicated that GRIP did not influence them to alter their herbicide application use relative to pre-GRIP conditions. Therefore, it appeared that GRIP had a slightly negative impact as evinced by a net increase in herbicide use and application rates in over half of the study areas.

Perennial Forages

An increase in perennial forage acreage is considered to be a positive impact from soil erosion prevention and wildlife habitat perspectives.

Contrary to economic logic, despite no coverage for forage crops under GRIP, GRIP apparently influenced farmers in 12 of 16 study areas to increase perennial crop acreage.

Only one soil zone (A4 in Manitoba) appeared to have more farmers who were influenced to decrease their acreages of forages rather than increase them. However, it should be recognized that the majority of producers (92%) indicated that GRIP did not influence them one way or the other. Hence, the positive impacts of forage acreage increase can be considered to be positive but minor in nature.

Tillage Practices

An increase in zerotillage use was deemed to be a positive impact because of soil erosion prevention and wildlife habitat improvement reasons.

Overall, in 14 of the 16 study areas, more farmers were influenced by GRIP to increase their acreages under minimum - and zerotillage systems. However, as less than 9% of the farmers in any given soil zone indicated that they were influenced by GRIP in one way or the other, the impact of GRIP on conservation tillage practices could be considered positive yet relatively small.

Summerfallow Acreage

A reduction in the amount of summerfallow acreage was deemed to be a positive impact in terms of the potential reduction in soil erosion, improved water quality and the provision of more wildlife habitat.

In 10 of the 13 study areas where summerfallowing was practised, more farmers decreased the amount of land in summerfallow as a result of GRIP. In three of the soil zones, the opposite was the case. Proportions of farmers influenced to change their summerfallow acreages in response to revenue insurance ranged from 3% to 11% for the affected soil zones. Furthermore, the actual decrease in summerfallow acreage amounted to approximately 1% in total summerfallow acreage in Western Canada. Thus, overall, GRIP is considered to have had a considerable positive impact from the perspective of reduced summerfallow acreage.

Summerfallow Cultivation Practices

A reduction in the number of times that summerfallow fields were cultivated was considered to be positive, primarily in terms of potential reduction in soil erosion.

GRIP influenced more farmers to decrease their number of cultivations in 2 of the 13 study areas where summerfallowing was practised. Apparently, GRIP had no effect on summerfallowing cultivation practices in the other 11 soil zones. However, less than 1% of the producers in these soil zones indicated that revenue insurance influenced their decisions. Overall, GRIP had a positive impact inasmuch as frequencies of cultivation were reduced.

Riparian Zones

Riparian zones are bands of vegetation associated with stream/river banks. While riparian zones usually include a minor proportion of the overall landscape, they are more productive in terms of plant and animal biomass than the overall landscape and are a critical source of biotic diversity within the ecoregion (Thomas et al. 1979).

An increase in riparian zone width as a result of GRIP influences on farming practices was considered to produce positive environmental impacts while the converse produced negative impacts.

The revenue insurance component of GRIP appeared to have a positive minor impact on riparian zone width in 5 of 16 study areas (primarily Ontario and the Atlantic provinces) and a negative minor impact in 3 zones, all in the Prairies. Mitigation measures will be necessary in the Prairie Provinces. The proportion of farmers who indicated a GRIP-related influence to decrease or increase riparian zone width was small (never more than 5%).

Field Margins

As field margins (i.e., borders of natural vegetation surrounding cultivated fields) are reduced or eliminated, so too are the remaining small portions of habitat for resident wildlife and for those species that rely upon these margins as travel corridors between habitats. A decrease in field margin widths was considered to be a negative impact based on the potential for reduced wildlife habitat and increased soil erosion.

Analyses of the survey data revealed that GRIP encouraged farmers to reduce their field margins in 7 of the 16 study areas. The percentage of producers who reduced their field margins in these 7 areas ranged from 0.3% to 3%. More importantly, GRIP encouraged farmers to reduce their field margins in 4 of the 12 Prairie Province study areas (soil zones A3 and B in Alberta; A3 in Saskatchewan; A3 in Manitoba).

GRIP also influenced producers in Ontario (soil zone E1), PEI and British Columbia to reduce their field margins. However, because less than 1% of these producers were influenced by GRIP to reduce their field margins, and because field margins in these areas were not identified in the initial scoping as critical or sensitive areas, we propose that the immediate (1991-1992) influence of GRIP in these areas were negligible on wildlife. However, if GRIP continues to influence field margin depletion in these areas, the cumulative impacts on wildlife could become more substantial.

In conclusion, mail survey analyses revealed that GRIP had a negative impact on uplands in 4 study areas within the Prairie Provinces. With regard to the study areas outside the Prairies, we recommend that these areas be monitored for cumulative losses in the years to come.

Wetland Margins

Wetland margins, the bands of natural vegetation surrounding wetland basins, provide critical nesting cover for waterfowl and other avian species, as well as important habitat for other wildlife. In agrarian settings, these margins also buffer wetlands from nutrient/toxin loading and sedimentation from adjacent croplands.

As farming practices encroach on wetland margins, the functional value of the wetlands to numerous wildlife species is seriously degraded. In fact, wetland basins that have had their margins destroyed by cultivation are of limited value to most wildlife species. Taking a conservative approach, we equated the loss of wetland margins with a loss in wetland function. Therefore, as outlined in section 3.5.1, a zero tolerance level was invoked in assessing the impact of GRIP on wetland margin degradation as well as wetland drainage; any decrease in wetland margin widths would be deemed a negative impact in terms of water quality (increased sediment and chemical loading) and reduced wildlife habitat.

Apparently, revenue insurance influenced farmers to reduce wetland margins in 2 of the 16 study areas, increase them in 3 areas and had no influence in the balance of study areas. However, in the soil zones where farmers were influenced, the number of farmers who claimed that they were influenced by GRIP was relatively small, ranging from less than 1% to 4%. Hence, the impacts on wetland margins overall was small. Nonetheless, inasmuch as a zero-tolerance threshold was established for wetland margin degradation, any impact was deemed negative and mitigation measures are necessary such that GRIP will not negatively impact wetlands in any region of Canada.

Wetland Drainage

Wetlands have a multitude of functions ranging from flood prevention and soil moisture enhancement to the provision of wildlife habitat (Environment Canada 1991). Canada has a policy that states that further wetland loss is undesirable and thus GRIP-related wetland losses would clearly be deemed a negative impact.

Overall, revenue insurance influenced farmers in 9 of 16 study areas to drain one or more of their wetlands during the first two years of GRIP. Although the numbers of farmers influenced by GRIP to undertake this drainage was small (1-5% per soil zone), any wetland loss exceeded the zero-tolerance threshold. Therefore, it appeared that GRIP had a negative impact on wetland basins in Canada during the first two years of the program and mitigation measures are necessary such that GRIP will not encourage wetland drainage in any region of the country.

Grasslands

The assessment of GRIP-related influences on grasslands relied upon determination of changes in acreages of grasslands as an indirect indicator of direction of impact.

Analyses of the survey data revealed that areal coverage of grazed grasslands increased in 4 of the study areas, decreased in 7 areas and remained the same in 5 areas (Table 5.2.3.4). Changes in areal coverage of ungrazed grasslands were similar, with increases on 5 study areas, decreases on 5, and no change on 6 areas. However, due to questionnaire length constraints, the survey was not designed to discern if these changes were influenced by GRIP. Therefore, we could not assess whether GRIP directly affected these grasslands in Canada. Nonetheless, it seems that, overall, GRIP was neutral or positively affected grazed or ungrazed grasslands in 9 of the study areas (i.e., those with no change or with increases in areal coverage between 1990 and 1992). Follow up assessments should attempt to measure if the program is causing a decline in native grasslands, especially in the Prairie Provinces. Indeed, section 3.5.1 provided compelling evidence for the need to conserve the remaining grasslands in the Prairie Provinces.

Woodlands/Shrublands

The assessment of GRIP-related influences on woodlands/shrublands relied upon determination of changes in acreages of these lands as an indirect indicator of direction of impact.

Analyses of the survey data revealed that areal coverage of grazed woodlands/shrublands increased in 6 of the study areas, decreased in 6 areas and remained the same in 4 areas (Table 5.2.3.4). Changes in areal coverage of ungrazed woodlands/shrublands were similar, with increases on 5 study areas, decreases on 7, and no change on 4 areas. However, the survey was not designed to discern if these changes were influenced by GRIP. Therefore, we could not assess whether GRIP directly affected these woodlands/shrublands in Canada. Nonetheless, it seems that, overall, GRIP was neutral or positively affected grazed or ungrazed woodlands/shrublands in 9 of the study areas (i.e., those with no change or with increases in areal coverage between 1990 and 1992). As with grasslands, follow up assessments should attempt to measure if the program is causing a decline in woodlands/shrublands within the farming communities of Canada.

5.3 SECONDARY INFORMATION

Information on land, fertilizer and pesticide use was obtained from secondary and primary sources. This information was reviewed in the context of whether following the introduction of the GRIP an NISA, perceptible changes had occurred. Changes were examined in the context of previous recorded observations rather than what may have occurred in the absence of either GRIP or NISA. The secondary information comprised data published by Statistics Canada or data obtained from agencies administering the GRIP program.

Reviewing the information on land use, fertilizers applied and pesticide sales for the years 1991 and 1992 in the context of previous records, suggests limited changes occurred. Total areas cultivated continued to increase in the Prairies; summerfallow followed a declining trend while lands growing annual and perennial corps expanded as they had in the past.

TABLE 5.2.3.4

PERCENT CHANGE IN AREAL COVERAGE OF WOODLANDS/SHRUBLANDS AND GRASSLANDS BETWEEN 1990 AND 1992 FOR FARMERS ENROLLED IN BOTH GRIP AND NISA PROGRAMS

	BC	ALBERTA					SASKATCHEWAN				MANITOBA			ONTARIO		PEI	N.S.	N.B.
	C2	A1	A2	A3	B's	C2	A1	A2	A3	C2	A3	A4	C2	C1	E1			
WOODLANDS/SHRUBLANDS																		
Grazed	+9	+37	-16	0	-5	-8	0	-8	+2	0	+6	+1	-1	0	-3	-11	+4	+9
Ungrazed	-5	0	0	+8	+3	-7	0	-14	+2	+5	-5	+2	0	-2	-2	-4	0	-3
GRASSLANDS																		
Grazed	-3	-1	+1	-1	-4	0	+3	0	0	+2	-4	+13	0	0	-8	-7	-5	-2
Ungrazed	0	-17	+25	0	+18	-10	0	-9	0	0	+33	-11	+8	0	-6	+19	+5	-10

Cultivated areas remained close to their twenty year average in eastern Canada while areas seeded to perennial crops continued to decline and were replaced by grain and oilseed crops. A consistent cropping pattern emerged for the farms enrolled in GRIP as opposed to those who chose not to join. Farms enrolled in GRIP seeded relatively more wheat, oilseeds and pulse crops than the farms growing crops without a GRIP contract. Non-GRIP participants seeded relatively more feed grains. These farms likely relied upon livestock sales to provide a larger share of their income than sales from wheat, oilseeds or pulse crops. Farmers contracting land under the GRIP program appeared to grow more wheat than they were planning to seed in western Canada while less land was seeded to oats in Ontario and the Prairie Provinces. The apparent adjustment to seeding more land to wheat and less to oats was consistent with the relatively larger revenue guarantees in the GRIP agreement.

Fertilizer sales showed no dramatic increases or decreases in 1991 and 1992 relative to the previous five years. Sales in the Atlantic Provinces, Quebec, Manitoba and Alberta remained closest to the levels recorded earlier, while Ontario and Saskatchewan sales continued to decline. Saskatchewan fertilizer sales in 1992 rose above the 1991 levels. Pesticide sales fell in all regions except the Atlantic Provinces. Usage of herbicides, insecticides and fungicides had been stable in the five years preceding GRIP. The magnitude of the drop in 1991 pesticide sales, however had occurred in previous years and therefore other factors than GRIP may have accounted for the reduced usage.

The secondary data seem to suggest that GRIP maintained the status quo with respect to land use, fertilizer and pesticide usage. Farmers growing cereal grains, oilseeds, and pulse crops were able to continue on with their previous agronomic practices. GRIP provided the assurance that their income would be maintained with minor changes to the farm business.

Finally, the land use diversity analyses of both 1986-1991 census data and the mail survey data indicated that GRIP had little impact on land use diversity.

6.0 STATISTICAL ANALYSIS OF SECONDARY DATA

6.1 INTRODUCTION

The statistical analysis of secondary data involved the use of three time series models and three cross-section models. The time series data were used to analyze the lands seeded to cereal grains and oilseeds, fertilizer and pesticide applications. The cross-section models utilized observations of land use at the municipal or county level. Data for the time series models were at the provincial level for the years 1961 to 1992. Only one year of data, namely 1991, was used in the cross-section models.

Historical information, compiled at the provincial level, was used to analyze whether 1991 and/or 1992 cropland, fertilizer and pesticide usage differed from previous years. Econometric models were specified and tested with respect to whether the recent input usage represented a significant departure from previous years. Events unique to 1991 which occurred prior to or shortly after spring seeding, were captured in the models by an all inclusive variable. Because the application form detailing the terms and conditions for NISA participation was not available until the latter part of July 1991, the model specification was not able to measure whether NISA was a contributing factor to differential input usage. Therefore, the results can only be related to participation in GRIP. Also, it must be noted that while the inclusive variable was called GRIP, it also reflected any other circumstances unique to the spring of 1991.

Models or results were not specified and/or reported for some provinces because a comparable data base was not available or the models were not statistically significant. This was especially true for pesticide usage where the predominant applications were not received by cereal grain and oilseed crops. The presence of a major horticultural industry in a province appeared to have a greater bearing upon annual pesticide sales than the circumstances surrounding grains and oilseed production.

6.2 TIME SERIES MODELS FOR LAND USE

In general, the models estimated the areas that were seeded to annual crops and summerfallow reasonably well. Models specified for the Prairie Provinces included additional variables to represent stocks of grain stored on the farm and weather conditions in the spring. Weather conditions and crop inventory appeared to have been a greater factor in determining the areas seeded in the Prairies than they were in the eastern Provinces. Our conclusions for the time series models on land use are listed below.

1. The intended areas that farmers plan to plant are accurate estimates of actual areas seeded if the spring weather, market conditions and government programs do not exhibit substantial changes from those anticipated in the winter.

2. In 1991, the introduction of the GRIP program resulted in a change in crops grown in Ontario and the Prairie Provinces but the changes which occurred in Quebec and the Atlantic provinces were within historical variations.

3. Summerfallow on the Prairie Provinces was estimated to be reduced by 6% in 1991 because of GRIP. The argument that the 1991 summerfallow reduction was linked more to timely spring rains than to GRIP would suggest the 1992 summerfallow area would have increased. However, 1992 reports indicated summerfallow was even lower than 1991 levels.

4. The 1991 area seeded to hard spring wheat was estimated to increase by 10% over the area that would have produced spring wheat in the absence of GRIP. The 1 085 000 more hectares of spring wheat largely came from 503 000 fewer hectares summerfallowed.

5. Prairie areas seeded to flax, oats and rye were estimated to be 13%, 25% and 42% lower then they would have been, while oats in Ontario was 14% lower. The circumstances underpinning the "would have been" condition imply the continuance of safety net programs similar to those familiar to farmers. Even though notice was given that WGSA would be terminated, Prairie farmers' expectations of the replacement program were probably based upon similar contractual arrangements. The model estimates suggested that 1991 GRIP resulted in a significant reduction of land producing flax, rye and oats.

6. While the estimates suggested that more barley and canola were seeded following the introduction of GRIP in 1991, these results relied more on a reallocation of the residual area not seeded to flax, oats and rye than on statistical significance estimated by the model.

7. The effects of GRIP upon the areas growing forage, pulses or other special crops were not estimated directly because of insufficient historical data. The models which estimated the total area seeded to cereal grains, oilseeds and summerfallow for the Prairie Provinces indicated that 322 000 more hectares were utilized by these crops in 1991 than was planned. This suggests 1% of the Prairie Provinces' land use was reallocated to these uses.

6.3 FERTILIZER MODEL

In general, the partial adjustment model used in the fertilizer analyses significantly explained fertilizer utilization in all provinces. Given the results of these analyses, we make the following conclusions.

1. Excluding Alberta, GRIP did not seem to have directly affected fertilizer use. However, if GRIP increases the area seeded to grains and oilseeds, fertilizer use is projected to increase.
2. Between 1966 and 1992, the estimators from the provincial models suggest that the annual level of fertilizer use was approximately half the long term most profitable amount. Circumstances such as uncertain crop yields, prices and sales tend to reduce fertilizer use relative to an environment where these are known.
3. Most of the expansion of seeded area on the Prairies was a function of reduced summerfallow acreage. Crops seeded into stubble normally receive more fertilizer. The model estimators showed that a 1% increase in the seeded area, which came predominantly from reduced summerfallow, increased fertilizer use by 1.6% to 5.3%.

6.4 PESTICIDE MODEL

The Nerlove type model employed to analyze pesticide use in the Prairies showed a high level of explanatory power. The following conclusions were drawn from the econometric results of this analysis.

1. Except for Alberta, GRIP has not had a significant impact on pesticide use in the Prairies. GRIP apparently was associated with a significant reduction in pesticide use in Alberta in 1991. The introduction of the "assurance recolte" in Quebec increased pesticide usage.
2. The area seeded to cereal grains and oilseeds directly influenced use of pesticides. An increase in seeded area increased pesticide use by a relatively larger amount and the trend toward continuous cropping could expand pesticide sales by an even larger percentage.
3. The effect of GRIP on pesticide use in the Prairie Provinces is likely to be more significant in terms of how it influences the total area seeded. Pesticide use is linked closely to weed and insect populations affecting cereal grains and oilseed crops. Thus, the total areas producing these crops will be instrumental in determining the amount of pesticides used. How the GRIP program influences the amount of

land seeded and the areas producing the various crops will be the most important factor affecting pesticide sales.

7.0 SIMULATION STUDIES TO ASSESS SOIL EROSION

Fiscal and temporal constraints rendered a detailed assessment of the effect of GRIP on all environmental components unfeasible. Therefore, it was decided that the environmental assessment would focus on 2 major environmental components: soils and wildlife habitat. The wildlife assessment was provided in section 5.0 as part of the descriptive assessment of the farmer survey data. Additional qualitative assessments were conducted on the effects of GRIP on other environmental components such as air quality, water quality and, by inference, fisheries.

Note an inherent difference between the assessment of GRIP's impacts on soil productivity and nonpoint source pollution (NPSP) risk and the assessment of GRIP's impact on wildlife habitat. The environmental impact assessment pertaining to wildlife habitat was inferred directly from the surveyed changes in land use attributable to GRIP. The environmental impacts pertaining to soil productivity and NPSP risk were estimated by adjusting the survey results according to the long-term soil productivity and NPSP risk trends. EPIC-derived simulations of long-term trends translated the surveyed land use changes into quantitative biophysical estimates of the impacts of GRIP on the environment and the sustainability of agricultural systems.

7.1 SOIL EROSION, SOIL PRODUCTIVITY AND NONPOINT SOURCE POLLUTION (NPSP)

Accelerated soil erosion can decrease soil productivity and increase nonpoint source pollution (Power 1987; Hargrove 1991). This negative environmental impact is the result of soil erosion's reduction of the soil's available water holding capacity (AWHC) through an accelerated depletion of topsoil and its inherent clay and organic matter fractions. This usually translates into water-stress for the crop and a concomitant reduction of the soil's ability to produce yield at a given level of input. As the soil is being eroded, nutrients contained in the sediment also wash away, some of which may be transported to neighbouring streams, lakes and rivers. This loading of surface water is referred to as nonpoint-source pollution, or NPSP. In addition, soluble nitrates and phosphates also can be transported by surface runoff, and percolation of the soil solution beyond the rooting zone. As the AWHC of the soil is decreased, the vertical percolation of water and soluble nutrients is increased. The resulting discharge of nutrients to groundwater is also an appreciable contributor to NPSP.

Rates of soil erosion can be estimated on a limited areal basis for particular farming practices by a number of empirical and deterministic models, most of which are to some extent related to the Universal Soil Loss Equation (USLE). These rates of soil erosion can then be compared to theoretical tolerable rates of soil erosion, or "T", to determine if they represent a risk to the long-term maintenance of soil productivity and NPSP abatement. These T-values were determined by the USDA's Soil Conservation Service (SCS) in the 1950's and 60's. They are based on theoretical rates of regeneration of the Ah horizon from the underlying B and/or C horizons. These T values, despite their usefulness, have been criticized for being unrealistic at times and too general in their geographical extent. More importantly, reliable T-values have not been systematically developed for most of Canada's agricultural region. Also, the T-value concept is inherently unscientific in that the models of topsoil regeneration cannot be validated using direct observation because of the geological time-frame required for topsoil formation. Models of soil depletion, on the other hand can be validated using information derived from actual replicated soil scalping experiments.

As an alternative to the establishment of T-values, some researchers have thus proposed that tolerable rates of soil erosion be set according to their impacts on soil productivity and NPSP. The rationale being that if existing rates of soil erosion do not cause an accelerated decrease in soil productivity and/or an accelerated increase in NPSP, they can be deemed acceptable for the time being. To determine which rates of soil erosion, and to which extent soil can be eroded before soil productivity and NPSP abatement are affected, researchers have performed soil scalping experiments. This removal of topsoil is meant to simulate the disappearance of topsoil over time. As an alternative to the physical removal of topsoil, a number of deterministic models also have been developed. The Erosion-Productivity Impact Calculator, or EPIC, is one such model. The model will simulate the impact of an incremental removal of a given layer of soil thickness on soil productivity and NPSP. The rate of soil removal (erosion), in millimetres of soil thickness per year (mm/yr), is a function of the farming practice specified by the user of EPIC. Because EPIC does not allow for the regeneration of the Ah horizon over time, soil erosion will eventually lead to a collapse of the soil's ability to produce biomass and abate NPSP. Depending on the farming system, this may require anywhere from 10 to 1000 iterations of the model, or simulation years.

To infer the rate of soil erosion and its impact on soil productivity and NPSP abatement for an area the size of southern Ontario or New-Brunswick required certain information. This included knowing the areal extent of the most prevalent, or at least the most consequential, farming systems and that the associated simulated rates of soil erosion have been obtained from models such as EPIC. These rates, once multiplied by the percentage areal extent (percent of total acreage), gave an estimate of that farming system's contribution to soil erosion, soil productivity decrease and NPSP. Because these farming systems occurred concurrently, the cumulative environmental impact of these farming systems on a given reporting area was the sum of their areal extent multiplied by their respective simulated rates of soil erosion. To calculate the cumulative impact of these farming systems attributable to GRIP, we calculated their contribution to the soil erosion before (1990) and after (1992) GRIP. We calculated the cumulative impact of seven prevalent and/or consequential farming systems as influenced by GRIP as of 1992 for each reporting area (Table 7.1). These values represent the average erosion rates for the reporting area weighted according to the change in the areal extent of prevalent land uses between 1990 and 1992. They represent the overall cumulative impact of these farming systems as influenced by GRIP.

TABLE 7.1

CUMULATIVE IMPACT OF SEVEN PREVALENT AND/OR CONSEQUENTIAL FARMING SYSTEMS INFLUENCED BY GRIP AS OF 1992 FOR EACH REPORTING AREA

The cumulative environmental impact of GRIP in terms of eroded soil thickness per year (mm/yr) due to a change in the areal extent of prevalent land uses attributable to GRIP. The critical threshold in years after the beginning of the simulation when the stated erosion rate causes a collapse in the soil productivity and nonpoint source pollution abatement is also indicated. Except for continuous and zerotillage corn in Ontario and continuous cereals in the Atlantic Provinces, all of the erosion rates associated with the various land uses did not appear to provoke such a collapse within the 400 simulation year period. In this respect, the minimal impact of GRIP in terms of mm of eroded soil per year was deemed inconsequential as of 1992, except of course under zerotillage and continuous corn farm systems in Ontario and the continuous cereals farm systems in the Atlantic Provinces.

Note:

Land use 1 = cultivated summerfallow (CSF)
Land use 2 = continuous cropping of corn, grains and oilseeds (CRP)
Land use 3 = chemfallow (CHF)
Land use 4 = zerotillage (ZT)
Land use 5 = perennial forages (FRG)
Land use 6 = improved pasture (PAS)
Land use 7 = grassland/range (RNG)

TABLE 7.1

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Province/Soil	Land-use	Erosion Rate (mm/yr)	Threshold (years)	Area 1990 (%)	Area 1992 (%)	Erosion 1990 (mm/yr)	Erosion 1992 (mm/yr)	Impact 90-92 (mm/yr)
BC/C2	CSF	1	> 400	6.77	5.12	0.0677	0.0512	-0.0165
	CRP	0.8	> 400	48.49	47.2	0.38792	0.3776	-0.01032
	CHF	0.85	> 400	0.16	0.31	0.00136	0.002635	0.001275
	ZT	0.75	> 400	1.44	8.29	0.0108	0.062175	0.051375
	FRG	0.5	> 400	12.39	14.49	0.06195	0.07245	0.0105
	PAS	0.3	> 400	8.32	8.81	0.02496	0.02643	0.00147
	RNG	0.2	> 400	3.55	3.51	0.0071	0.00702	-0.00008
							Cumulative Impact	0.03772
Alberta/A1	CSF	0.45	> 400	22.03	22.41	0.099135	0.100845	0.00171
	CRP	0.35	> 400	40.36	40.48	0.14126	0.14168	0.00042
	CHF	0.3	> 400	3.16	1.76	0.00948	0.00528	-0.0042
	ZT	0.25	> 400	5.69	5.28	0.014225	0.0132	-0.00103
	FRG	0.2	> 400	3.55	3.44	0.0071	0.00688	-0.00022
	PAS	0.15	> 400	3.65	4.22	0.005475	0.00633	0.000855
	RNG	0.1	> 400	22.92	22.57	0.02292	0.02257	-0.00035
							Cumulative Impact	-0.00281
Alberta/A2	CSF	0.3	> 400	17.84	15.6	0.05352	0.0468	-0.00672
	CRP	0.23	> 400	57.15	57.03	0.131445	0.131169	-0.00028
	CHF	0.2	> 400	3.08	5.08	0.00616	0.01016	0.004
	ZT	0.18	> 400	4.48	7.7	0.008064	0.01386	0.005796
	FRG	0.12	> 400	3.31	3.45	0.003972	0.00414	0.000168
	PAS	0.08	> 400	2.48	2.71	0.001984	0.002168	0.000184
	RNG	0.06	> 400	11.52	11.61	0.006912	0.006966	0.000054
							Cumulative Impact	0.003206
Alberta/A3	CSF	0.3	> 400	5.12	4.08	0.01536	0.01224	-0.00312
	CRP	0.29	> 400	71.04	70.64	0.206016	0.204856	-0.00116
	CHF	0.28	> 400	1.65	2.31	0.00462	0.006468	0.001848
	ZT	0.33	> 400	0.24	2.23	0.000792	0.007359	0.006567
	FRG	0.2	> 400	4.32	4.91	0.00864	0.00982	0.00118
	PAS	0.15	> 400	2.68	2.88	0.00402	0.00432	0.0003
	RNG	0.1	> 400	8.44	8.34	0.00844	0.00834	-0.0001
							Cumulative Impact	0.005515

TABLE 7.1

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Province/Soil	Land-use	Erosion Rate (mm/yr)	Threshold (years)	Area 1990 (%)	Area 1992 (%)	Erosion 1990 (mm/yr)	Erosion 1992 (mm/yr)	Impact 90-92 (mm/yr)
Alberta/B4	CSF	0.8	> 400	11.15	8.82	0.0892	0.07056	-0.01864
	CRP	0.5	> 400	53.02	53.67	0.2651	0.26835	0.00325
	CHF	0.55	> 400	0.58	1.28	0.00319	0.00704	0.00385
	ZT	0.45	> 400	0.91	2.87	0.004095	0.012915	0.00882
	FRG	0.3	> 400	6.5	7.47	0.0195	0.02241	0.00291
	PAS	0.2	> 400	2.34	3.13	0.00468	0.00626	0.00158
	RNG	0.15	> 400	10.46	10.08	0.01569	0.01512	-0.00057
						Cumulative Impact		0.0012
Alberta/C2	CSF	1.25	> 400	5.59	5	0.069875	0.0625	-0.00738
	CRP	0.8	> 400	46.44	46.23	0.37152	0.36984	-0.00168
	CHF	0.85	> 400	0.29	0.45	0.002465	0.003825	0.00136
	ZT	0.75	> 400	0.09	0.35	0.000675	0.002625	0.00195
	FRG	0.5	> 400	14.3	15.98	0.0715	0.0799	0.0084
	PAS	0.3	> 400	8.17	8.01	0.02451	0.02403	-0.00048
	RNG	0.2	> 400	2.48	2.48	0.00496	0.00496	0
						Cumulative Impact		0.002175
Sask/A1	CSF	0.4	> 400	31.16	31.43	0.12464	0.12572	0.00108
	CRP	0.6	> 400	47.43	45.97	0.28458	0.27582	-0.00876
	CHF	0.3	> 400	4.91	5.5	0.01473	0.0165	0.00177
	ZT	0.23	> 400	19.33	22.01	0.044459	0.050623	0.006164
	FRG	0.15	> 400	0.98	1.08	0.00147	0.00162	0.00015
	PAS	0.09	> 400	1.4	1.58	0.00126	0.001422	0.000162
	RNG	0.07	> 400	10.67	10.99	0.007469	0.007693	0.000224
						Cumulative Impact		0.00079
Sask/A2	CSF	0.35	> 400	31.06	29.08	0.10871	0.10178	-0.00693
	CRP	0.35	> 400	53.41	54.18	0.186935	0.18963	0.002695
	CHF	0.23	> 400	1.3	2.57	0.00299	0.005911	0.002921
	ZT	0.18	> 400	7.89	16.09	0.014202	0.028962	0.01476
	FRG	0.1	> 400	1.7	1.94	0.0017	0.00194	0.00024
	PAS	0.08	> 400	0.95	1.06	0.00076	0.000848	0.000088
	RNG	0.05	> 400	5.97	6.07	0.002985	0.003035	0.00005
						Cumulative Impact		0.013824

TABLE 7.1

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Province/Soil	Land-use	Erosion Rate (mm/yr)	Threshold (years)	Area 1990 (%)	Area 1992 (%)	Erosion 1990 (mm/yr)	Erosion 1992 (mm/yr)	Impact 90-92 (mm/yr)
Sask/A3	CSF	0.8	> 400	16.54	13.57	0.13232	0.10856	-0.02376
	CRP	0.88	> 400	62.59	63.91	0.550792	0.562408	0.011616
	CHF	0.7	> 400	0.36	1.6	0.00252	0.0112	0.00868
	ZT	0.15	> 400	0.85	4.22	0.001275	0.00633	0.005055
	FRG	0.09	> 400	2.92	3.42	0.002628	0.003078	0.00045
	PAS	0.06	> 400	2.04	2.11	0.001224	0.001266	0.000042
	RNG	0.03	> 400	4.32	4.34	0.001296	0.001302	0.000006
						Cumulative Impact		0.002089
Sask/C2	CSF	2.25	> 400	12.7	9.8	0.28575	0.2205	-0.06525
	CRP	1.7	> 400	51.9	52.09	0.8823	0.88553	0.00323
	CHF	1.75	> 400	0.4	0.91	0.007	0.015925	0.008925
	ZT	1.63	> 400	2.33	5.56	0.037979	0.090628	0.052649
	FRG	0.43	> 400	7.11	8.23	0.030573	0.035389	0.004816
	PAS	0.24	> 400	2.56	3.05	0.006144	0.00732	0.001176
	RNG	0.11	> 400	5.14	5.18	0.005654	0.005698	0.000044
						Cumulative Impact		0.00559
Manitoba/A3	CSF	0.45	> 400	4.12	3.56	0.01854	0.01602	-0.00252
	CRP	0.35	> 400	76.06	75.63	0.26621	0.264705	-0.00151
	CHF	0.33	> 400	0.05	0.2	0.000165	0.00066	0.000495
	ZT	0.22	> 400	2.36	4.55	0.005192	0.01001	0.004818
	FRG	0.12	> 400	4.18	4.7	0.005016	0.00564	0.000624
	PAS	0.07	> 400	1.03	1.13	0.000721	0.000791	0.00007
	RNG	0.04	> 400	2.83	2.69	0.001132	0.001076	-0.00006
						Cumulative Impact		0.001926
Manitoba/A4	CSF	0.15	> 400	5.53	4.04	0.008295	0.00606	-0.00224
	CRP	0.14	> 400	64.18	65.43	0.089852	0.091602	0.00175
	CHF	0.13	> 400	0.06	0.07	0.000078	0.000091	0.000013
	ZT	0.13	> 400	1.47	3.97	0.001911	0.005161	0.00325
	FRG	0.07	> 400	9.59	9.95	0.006713	0.006965	0.000252
	PAS	0.05	> 400	1.98	1.98	0.00099	0.00099	0
	RNG	0.03	> 400	2.35	2.73	0.000705	0.000819	0.000114
						Cumulative Impact		0.003144

TABLE 7.1

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Province/Soil	Land-use	Erosion Rate (mm/yr)	Threshold (years)	Area 1990 (%)	Area 1992 (%)	Erosion 1990 (mm/yr)	Erosion 1992 (mm/yr)	Impact 90-92 (mm/yr)
Manitoba/C2	CSF	0.9	> 400	8.52	6.56	0.07668	0.05904	-0.01764
	CRP	0.58	> 400	54.83	56.51	0.318014	0.327758	0.009744
	CHF	0.63	> 400	0	0.09	0	0.000567	0.000567
	ZT	0.21	> 400	0.9	2.03	0.00189	0.004263	0.002373
	FRG	0.12	> 400	9.55	9.66	0.01146	0.011592	0.000132
	PAS	0.09	> 400	2.62	2.64	0.002358	0.002376	0.000018
	RNG	0.06	> 400	3.5	3.51	0.0021	0.002106	0.000006
							Cumulative Impact	-0.0048
Ontario/C1	CRP	8.18	< 100	76.11	76.2	6.225798	6.23316	0.007362
	ZT	5.81	< 150	4.71	10.36	0.273651	0.601916	0.328265
	FRG	1	> 400	6.95	7.39	0.0695	0.0739	0.0044
	PAS	0.7	> 400	2.9	3.12	0.0203	0.02184	0.00154
	RNG	0.4	> 400	0.86	0.92	0.00344	0.00368	0.00024
							Cumulative Impact	0.341807
Ontario/E1	CRP	8.18	< 100	37.03	38.02	3.029054	3.110036	0.080982
	ZT	5.81	< 150	1.1	3.29	0.06391	0.191149	0.127239
	FRG	1	> 400	20.71	20.89	0.2071	0.2089	0.0018
	PAS	0.7	> 400	11.43	11.33	0.08001	0.07931	-0.0007
	RNG	0.4	> 400	6.55	6.14	0.0262	0.02456	-0.00164
							Cumulative Impact	0.207681
Atl. Prov./C2	CRP	5.8	< 150	29.58	29.74	1.71564	1.72492	0.00928
	ZT	1.88	> 400	1.45	2.22	0.02726	0.041736	0.014476
	FRG	0.7	> 400	11.21	11.54	0.07847	0.08078	0.00231
	PAS	0.4	> 400	4.15	4.44	0.0166	0.01776	0.00116
	RNG	0.2	> 400	4.09	3.95	0.00818	0.0079	-0.00028
							Cumulative Impact	0.026946
Atl. Prov./D2	CRP	19	< 150	24.19	23.56	4.5961	4.4764	-0.1197
	ZT	7.5	> 400	2.05	2.99	0.15375	0.22425	0.0705
	FRG	1.2	> 400	7.38	7.57	0.08856	0.09084	0.00228
	PAS	0.98	> 400	3.62	3.17	0.035476	0.031066	-0.00441
	RNG	0.3	> 400	2.24	2.26	0.00672	0.00678	0.00006
							Cumulative Impact	-0.05127

Any increase in agricultural land use will lead to an increase in soil erosion. Assuming a constant amount of agricultural land, the average erosion rate for the reporting area will either increase or decrease according to the relative change in the areal extent of land uses differing in their contribution to soil erosion. If the shift was from a highly erosive land use such as cultivated summerfallow, to a more conservation-oriented land use such as zerotillage or improved pasture, the average erosion rate for the reporting area and the cumulative impact reported in Table 7.1 decreased. If the shift was from a conservation-oriented land use such as grassland/pasture, to a more erosive land use such as chemfallow, or even zerotillage, the cumulative environmental impact in terms of soil erosion increased. This type of analysis points to the fact that a mere increase in zerotillage, for instance, generally considered a means to soil conservation, does not necessarily imply a reduction in the average erosion rate for that reporting area, especially if the increased zerotillage acreage was previously under pasture or grassland. For instance, the bulk of the increase in the average erosion rate of the E1 reporting area in Ontario was attributable to an increase in the acreage of zerotillage (Table 7.1). This does not mean to say that zerotillage in itself will necessarily have detrimental effects on soils, but that for the sake of sustainable agriculture in the E1 reporting area of Ontario, zerotillage should not be sponsored at the expense of pasture, grassland or perennial forages. This applies to all reporting areas, but even more so in Ontario because of the apparent unsustainability of corn cropping in Ontario's E1 and C1 reporting areas.

7.2 SUMMARY AND CONCLUSIONS

Overall, the environmental impacts as calculated in terms of mm of eroded soil per year (mm/yr) for all reporting areas were negligible, representing only a fraction of a mm per year. More importantly, the erosion rates associated with each of the land uses except for continuous and zerotillage corn in Ontario, and for continuous cereals in the Atlantic Provinces, do not appear to pose an immediate threat to sustained soil productivity. The EPIC simulations were continued for over 400 simulation years. Only under the continuous corn farming system in Ontario and under the continuous cereals farming system in the Atlantic Provinces did the soil system collapse; which was after 100 to 150 simulation years, when they ceased to yield crop and biomass (Table 7.1). It can thus be concluded that, except for these cases, small or negligible, increases or decreases in the overall average soil erosion rate of the reporting areas is probably acceptable for sustainable agriculture.

8.0 SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

8.1 ASSESSMENT OF ENVIRONMENTAL ISSUES

In the preceding chapters, several lines of investigation were followed in order to assess the environmental impacts of GRIP, and to find answers to the specific questions raised in chapter two. The different lines of investigation did not always lead to consistent findings. This in itself should not be surprising because the methodological approaches were so different in each case; but it does point to a need to integrate all the findings and to explain apparent contradictions in a way that permits intelligent conclusions to be reached.

It was felt that the greatest weight should be given to the quantitative analysis of survey data and statistical analysis of census and other secondary data. The conceptual and theoretical description of GRIP, and the opinions expressed in the written submissions, were felt to warrant much less weight. Somewhere in between in terms of weighting were the simulation studies of soil degradation and non-point source pollution. Hence, our conclusions are generally more in line with the evidence provided directly by program participants.

8.1.1 GRIP Participation

Some farmers chose to sign a GRIP agreement while others did not. Potentially, a total of 65.4 million acres of Canadian cropland qualified for GRIP. Throughout Canada, a total of 51 million acres were enrolled. Provincial participation ranged from 47% of the eligible cropland in Quebec and New Brunswick to 85% in Ontario. Table 8.1 shows that the participation was the highest in the Prairie Provinces and Ontario, and was the lowest in the Atlantic Provinces and Quebec.

The environmental impact to the extent that the GRIP agreement influenced farm decisions was limited to the areas under contract. The larger absolute and relative areas under contract were in the prairie region of Canada. This region accounted for 45.4 million acres or 89% of all GRIP cropland enrolled in Canada. Because of the extensive area involved in the prairie region, the potential impact upon the agroecosystem is greater here than in other parts of Canada.

8.1.2 Land Use

The evidence in terms of how farmers used land assigned under a GRIP contract was limited to 1991 and 1992, the first two years of the agreement. Data obtained from the survey of farmers and secondary sources were not always consistent with the opinions expressed by written submissions or conclusions reached through economic rationale. While the arguments presented in the submissions or advanced on the basis of economic behaviour of farmers were logically consistent, they were unable to account for all the diverse circumstances that influenced farmers' land use decisions. For example, forage crops were not eligible under GRIP.

TABLE 8.1

PARTICIPATION IN GRIP

PROVINCE	PERCENTAGE OF ELIGIBLE LAND ENROLLED (1992)
British Columbia	59
Alberta	72
Saskatchewan	83
Manitoba	79
Ontario	85
Quebec	47
New Brunswick	47
Prince Edward Island	49
Nova Scotia	52
Canada	78

8.1.2.1 Forage Crops and Livestock Production

Conventional wisdom and arguments based upon economic theory suggested farmers would tend to grow more GRIP eligible crops and reduce the areas seeded to perennial grasses and legumes, but this was not the case in the first two years of GRIP. Firstly, the secondary data indicated regions with relatively more land growing forages had lower enrolments in GRIP, and at the provincial level, the 1991 and 1992 areas seeded to tame hay increased or did not deviate from a declining trend. Secondly, the primary data showed that 92% of the farmers enrolled in GRIP did not change the area in forages and for those changing the forage land base, more farmers increased the area than decreased it.

The secondary data implied that diversified crop/livestock farms were less inclined to sign a GRIP agreement than specialized grain farmers. Furthermore, the potential income to be realized through cattle or milk production had a major bearing upon forage production. Revenues from cow/calve and stocker/feeder enterprises increased during the first two years of the GRIP agreement. On the other hand, where dairy was the predominant enterprise, the milk delivery quotas declined; thus, fewer dairy cows were required and the need for forage diminished. The dynamics of the livestock sector had a direct bearing upon land use as well as the events affecting cereal grains and oilseed crops.

Conclusions advanced from theoretical analysis or written submissions often assumed everything remained constant except the introduction of a new program like GRIP. For example, when livestock prices change, the conclusions were not consistent with what were observed. This does not mean the theoretical framework was wrong but merely the set of assumptions were incorrect with respect to the livestock market. The theoretical analysis must be retained to evaluate the question of whether even more forage crops would have been grown if they were eligible for GRIP.

Forages, because of their bulk density, are consumed close to the source of production. It follows that the demand for forages is linked to the cattle population in a region. The regional cattle herd depends upon the revenues from meat or milk and the limits and costs of expanding the number of animals. One important livestock cost is forage. A major cost in the production of grasses and legumes is land. When land seeded to cereals, oilseeds and pulse crops qualifies for revenue insurance and if similar guarantees are not available for forages, this increases the opportunity cost of growing forages. Therefore, unless comparable funds are provided through tripartite red meat stabilization or administered milk prices, then GRIP in the long run, should result in lower levels of forage production than if grasses and legumes qualified for revenue insurance.

Observed data in 1991 and 1992 appeared to contradict this conclusion because forage areas increased. This was likely attributable to forage requirements for beef producers who were receiving favourable levels of revenue during this period. The question remains, however, would the expansion have been greater if forages qualified for GRIP? Forages are linked closely to the regional cattle population and for 1991 and 1992, it was unlikely these populations were affected. Future growth of the beef and milk industry, however, will be influenced by the cost of forages and GRIP inflated forage costs should slow the rate of growth.

8.1.2.2 GRIP Eligible Crops

Clearly, the farms enrolled in GRIP had a higher share of wheat, corn, oil seeds and pulse crops than the farms not enrolled. Non-participants had relatively more feed grains (oats, barley, rye, and mixed grains). The regional statistical analysis for Manitoba, Saskatchewan and Alberta also showed that as the non-eligible crops (forages, horticulture) in a municipality increased, the enrolment of the land eligible for GRIP coverage decreased. Farms producing grains and oilseeds along with relatively more forages tended not to join GRIP. The non-eligible crop areas were also positively related to the cattle population. Therefore, farms not enrolled in GRIP were more diversified farms. Farms enrolled in GRIP were likely to have been less diversified in 1990 prior to GRIP and GRIP represented a convenient opportunity to maintain the status quo. If stabilization funds had not been linked to crops per se, and an expended NISA program including livestock had been available, many farmers would have explored and some probably would have expanded other cropping and livestock enterprises. Instead, given the conditions under which farmers qualified for GRIP support, they maintained their specialized grain farms which became even more specialized because of the differential crop revenues guaranteed in the contract.

Depending upon the area, the survey results indicated that between 11% and 33% of the farmers said they considered the terms of the GRIP contract when selecting which crops to seed. Secondary data analysis relating the areas seeded to seeding intentions, crop prices and weather confirmed this for 1991. Prairie farmers revised the area planted to spring wheat upwards after they signed a GRIP contract and reduced the areas seeded to oats. Ontario farmers also cut back from their planned oat production in 1991. These changes were tied primarily to the relatively higher target revenue for wheat. Adjustments of this nature are unique for the year in question because the relationship between a crop's target revenue and expected market revenue change with prices. Therefore, the target revenues tended to improve the relative profitability of wheat more than the other crops in 1991 and 1992, but this will change from year to year. Therefore, crop specific, revenue insurance will vary from year to year, in terms of its influence upon crop selection.

A more permanent influence upon crop selection would be how farmers perceived revenue insurance and crop insurance reduced risk. With the exception of 1992 revenue insurance in Saskatchewan, between 60% and 71% of the respondents believed farming was less risky under GRIP. Risk reduction was perceived not on a crop by crop basis but in terms of all crops. Therefore, crops which historically had greater price volatility and/or year to year yield variation were not believed to be less risky because of GRIP. Possibly, over time, as farmers gain a greater understanding of the GRIP contract they will assess the risk reduction crop by crop. However, this was not the situation in 1992. Risk generally was believed to be lower with revenue insurance and crop insurance but it had minimal influence upon crop selection and farming practises.

Cropping diversity also was evaluated in terms of the actual areal extent of crops in each of the 17 reporting areas using the Land Use Diversity Index (LUDI). The land use diversity indices did not change appreciably between the 1986 and 1991 census periods. This could be considered a first order indication that neither GRIP nor NISA programming in 1991 had an impact of land use diversity. We also completed a similar analysis using the actual survey data collected on a reporting area basis. This data was less aggregated geographically, but more so according to crop and land use. Nevertheless, the analysis complemented the above analysis and corroborated its conclusions.

8.1.2.3 Cultivation and Summerfallow

Summerfallow area was reduced in 10 of the 13 study areas surveyed. Secondary analysis indicated that farmers revised their summerfallow intentions in the spring of 1991. The secondary analysis concluded that the actual 1991 summerfallow would have been the same as the intended area. The actual area in 1991 was a million acres below the March intentions. The survey of farmers attributed about a quarter of the reduction or 250 000 acres to GRIP. Reduced summerfallow is considered to be a positive impact on both soil and water quality. Frequency of cultivation of the land remaining in summerfallow was reduced in 2 of the 13 farming areas whereas no change occurred in the remaining 11. Therefore, with respect to summerfallow, the GRIP agreement was deemed to be a positive impact in terms of the potential reduction in soil erosion, improved water quality and the provision of more habitats.

8.1.2.4 Marginal Lands and Wildlife Habitat Including Wetlands

Marginal lands are environmentally sensitive because of their biophysical characteristics as wildlife habitat, wetlands, riparian zones, native prairie and/or highly erodible lands. Marginal lands have consistently been vulnerable to development as a result of economic pressures on producers. For example, as of 1990, over 71% of Canada's wetlands have been drained and 82% of prairie wetland margins have been cleared or cultivated for agricultural expansion (Environment Canada 1991). Agriculture Canada has stated that GRIP should not encourage the breaking up of new land at the expense of wetlands, native prairie and other wildlife habitat areas. Moreover, the Federal-Provincial Safety Net Committee stated, "programs should not encourage cereal production on fragile lands." This was one of the criteria for evaluating safety net programs that the Safety Net Committee developed.

In its 1992 format, GRIP provided no disincentives to undesirable modifications in land use, particularly in environmentally sensitive areas. In fact, several Canadian agricultural economists have suggested that GRIP may encourage farmers to break up marginal lands (Gray et al. 1991). These concerns were echoed by Environmental NGO's, the United States Department of Agriculture and by interviewees from Alberta, British Columbia, Manitoba, Ontario, and Saskatchewan. These concerns were most pronounced in the Prairie Provinces, where the majority of wetlands and the adjoining upland margins have been targeted for protection under the North American Waterfowl Management Plan (NAWMP).

The primary objective of the NAWMP's Prairie Habitat Joint Venture (PHJV) is to protect and enhance 1.5 million ha of waterfowl habitat in Manitoba, Saskatchewan, and Alberta. Several interviewees and providers of written briefs from these provinces were concerned that GRIP would encourage farmers to drain wetlands and/or destroy the critical upland margins adjacent to these wetlands. Our survey results revealed that GRIP influenced 1% to 5% of the farmers in 9 of the 16 study areas to drain wetlands. Moreover, farmers in one half of the prairie soil zones admitted being influenced by GRIP to drain. Farmers in 2 of the 16 study areas indicated that they were influenced by GRIP to encroach upon wetland margins but the proportion of those influenced was small (<2%). Thus, because GRIP encouraged wetland habitat degradation across the country, it is in direct conflict with the Federal Policy on Wetland Conservation, the NAWMP and recommendations of the Federal-Provincial Safety Net Committee and therefore represents a negative impact.

The mail survey also revealed that GRIP influenced farmers in 7 study areas to reduce their upland field margins and in 3 study areas to reduce their riparian zones. The mail survey was not designed to ascertain the influence of GRIP on grasslands or woodlands. However, it appeared that GRIP did not contribute to the reduction of grasslands or woodlands in the majority of study areas. Furthermore, as of 1992, GRIP apparently influenced few to convert their perennial crops to GRIP-eligible crops. Indeed forage production acreage increased on farms enrolled in GRIP. Additionally, conservation tillage practices and a reduction in summerfallow would be expected to produce benefits for wildlife. Thus, despite some losses of field margin and riparian habitats, there were compensatory increases in habitat through changing land use practices that would suggest that the overall impact of GRIP on upland habitat was neutral.

With respect to contractual set aside lands, it is not clear whether GRIP influenced these land use practices. Due to the costs of converting wetlands and other wildlife habitat such as woodlots to annual crop production, the economic incentives to continue this trend will depend directly on prices farmers receive from the marketplace and on the magnitude of ongoing financial support from governments to maintain net incomes in crop production. Interviewees in all provinces except Ontario voiced concern that GRIP might encourage wetland and woodland conversion to croplands due to the acreage-based nature of the program and the relatively high level of financial support it presently provides. Moreover, several reports (e.g., van Kooten and Schmitz 1992, Thompson and Young 1992), interviewees and providers of written briefs voiced concern that existing wildlife/soil conservation easement programs such as the Permanent Cover Program (PFRA), Prairie Care (DU Canada), and PHJV initiatives might not be able to compete with GRIP. Hence, an unknown portion of lands currently protected for wildlife/soil conservation might eventually be converted to GRIP-eligible croplands. However, when comparing actual government expenditures to procure land for the PHJV program to expenditures for GRIP, Gray (1992) and Lynch-Stewart et al. (1993) concluded that in all three Prairie Provinces, both federal and provincial governments save at least three times the cost of the PHJV in agricultural subsidy reductions. Hence, any reduction in PHJV expenditures would increase total taxpayer costs when agricultural subsidy payments are considered.

At present, there is little information on the degree in which GRIP affected, or will affect, producer decisions to enrol or cancel existing conservation set aside programs. Therefore, this is an area that needs to be monitored in the years to come. The economic and environmental benefits of alleviating this potential problem could be substantial.

8.1.2.5 Soil Erosion and Non-point Source Pollution

The effect of GRIP on soil erosion was assessed through a variety of analyses ranging from examination of farming practices through detailed modelling using EPIC simulations. Summerfallowing, a practice primarily confined to the Prairies of Canada, is widely considered to have negative implications for soil erosion because the soil is left exposed to the elements. Summerfallow acreage in the Prairies was reduced by 6% (over 500 000 ha) under GRIP, with 15% of the farmers responding to our survey indicating they were influenced by GRIP to reduce their use of summerfallow. GRIP apparently led to the cultivation and re-seeding of 75 000 ha of fall rye crops in its first year of operations which created the potential for soil erosion that winter.

Farming practices such as conservation tillage or forage crops help to prevent erosion because the residue of former crops or year-round vegetative cover makes the underlying soils less vulnerable to the erosive forces of wind and water. GRIP influenced an increase in the use of conservation tillage practices across Canada, with expected associated decreases in erosion. Of interest, was the response by 8% of the farmers surveyed that GRIP influenced them to increase their acreages of forage crops despite the fact that GRIP offers no economic incentives to do so.

Parallel analyses using EPIC simulations revealed that environmental impacts of GRIP as measured by mm of soil eroded per year were negligible (a fraction of a mm per year). GRIP did not appear to pose a threat to sustained soil productivity or increased non-point source pollution even when farming systems as practised under GRIP conditions were simulated for over 100 years.

8.1.3 Chemical Use and Water Quality

Fertilizers and pesticides are an integral part of conventional cropping practices. Any change in application rates and methods were assessed in terms of theory as well as reviewing evidence from secondary and primary data. Contractual terms in the revenue and crop insurance agreements indicate moral hazard is likely to involve reduced usage of fertilizer and pesticides. Lower usage will reduce the risks of environmental losses but increase the potential indemnities from revenue and crop insurance. In order to minimize moral hazard related indemnities, the contracts require that farmers follow cropping practices which under normal circumstances would result in the yields assigned in the contract. Terms in the revenue and crop insurance contracts should not result in chemical use exceeding the levels used by farmers not enrolled in GRIP.

The theoretical analysis indicated that the revenue insurance contracts in the Atlantic Provinces, Saskatchewan and British Columbia had the highest potential for moral hazard. However, analysis of the farm survey data from these provinces as well as secondary data on fertilizer sales indicated that reduced applications were not widespread. Survey data from the remaining provinces also indicated no appreciable changes in fertility management strategies once a GRIP contract was signed. With the exception of Alberta, the analysis of provincial fertilizer sales data concluded that 1991 and 1992 were no different than the previous 25 years in terms of the factors underpinning sales. Alberta fertilizer sales were significantly lower than expected for 1991 and 1992, and GRIP may have been a contributing factor. However, these findings were not consistent with theory, as Alberta farmers under a GRIP contract had the same added income incentive to apply fertilizer as those not enrolled. The survey of Alberta farmers did not imply any apparent changes in fertilizer practices.

Fertilizer use is expected to increase more rapidly in the prairie region because GRIP has accelerated the decline of summerfallow. Crops seeded on stubble normally require additional nitrogen. When inorganic fertilizers are applied to augment the nitrogen already available in the soil, the combined levels normally are consumed by the crop. Therefore, leaching and surface runoff losses of nitrogen are potentially lower as summerfallow decreases and the application of inorganic nitrogen fertilizer increases. Thus, when more organic fertilizer is used in the context of reducing summerfallow, water quality is likely to improve.

Theoretically, the presence of moral hazard in the GRIP contract could have reduced pesticide usage. However, secondary and primary data analyses on pesticide use did not substantiate any change. Moreover, the farmer survey indicated the status quo prevailed in 90% to 98% of the farms. For the 2-10% of the farms that changed pesticide usage because of GRIP, the number who increased usage exceeded those reducing their use. The analyses of provincial pesticide sales concluded that 1991 sales in Alberta were significantly lower than expected and pesticide sales since the income assurance program was introduced in Quebec were consistently higher. Significantly lower Alberta sales also occurred for fertilizers. The Alberta farmers that were surveyed did not indicate a reduction in either pesticides or fertilizers.

Both primary and secondary sources of data indicated that as of 1992, GRIP had no appreciable impact on chemical use in Canadian agriculture. Hence, it could not be concluded that GRIP contributed to contamination of surface or groundwater. Additionally, our long-term EPIC simulations for non-point source pollution revealed no increased likelihood of non-point source pollution in the foreseeable future. Indeed, as a result of decreased summerfallow, increased conservation tillage and increased acreages of forage crops, one could reasonably expect less soil erosion with a concomitant reduction in chemicals entering surface and groundwater.

8.1.4 Air Quality

Data to determine the implications of GRIP on air quality were not available. However, a previous study commissioned by the PFRA aimed at assessing some of the environmental impacts of PFRA's Permanent Cover Program, and in particular its impact on agriculture's carbon dioxide emissions, indicated that land enrolled in PCP could potentially act as carbon sinks. To the extent that carbon dioxide emissions are considered an air quality issue, GRIP-related apparent short term benefits associated with conservation farming practices and increased forage acreage could be contributing to storing a portion of the carbon dioxide otherwise emitted by agricultural soils. The whole issue of agriculture as a carbon sink and source has been dealt with in a 1990 (ASA) monograph (Kimball 1990).

8.2 RECOMMENDATIONS/MITIGATION MEASURES

The recommendations contained herein arise from the expectations in the Terms of Reference that recommendations be made based upon the following sub-headings. It is also recognized that the GRIP National Committee desires to have input on the final recommendations regarding program review.

8.2.1 Recommendations From Written Submissions

Representatives of Canada's agri-food industry and interest groups submitted briefs regarding the environmental implications of GRIP. In some cases the contributors provided suggestions about how perceived short-comings of GRIP might be improved. A summary of those recommendations is provided in Figure 8.2.

Provide Support to Alternative Land Uses

This was a broad-ranging category in that it included recommendations for inclusion of not only forages in the form of permanent cover establishment programs but also wildlife habitat enhancement projects. The nature of this recommendation was basically one of ensuring that GRIP encompasses all farm-related activities, rather than just grains and oilseeds.

Inclusion of Forages

Here, recommendations were explicit about the need for inclusion of forages under GRIP. The mechanics of how this might be administered were not stated but rather, the emphasis was on ensuring inclusion of the livestock industry, protection of erosion prone lands and provision of alternative benefits to wildlife habitat.

FIGURE 8.2

RECOMMENDED CHANGES TO GRIP BASED ON WRITTEN SUBMISSIONS

Organization/Individual	Provide Support to Altern. Land Use	Include Forages	Cross Compliance	Convert to Indiv. Yields	Provide Incentives to Organic Prod.	Provide Incentives to Superior Producers
• Manitoba Farmer	✓					✓
• Manitoba Organic Produc. Assoc.	✓				✓	
• Manitoba Instit. Agrol.	✓		✓			
• Ontario Corn Producers Assoc.				✓		
• Sask. Organic Farmer	✓				✓	
• Sask Wetland Conserv. Corp.	✓					
• Sask. Wheat Pool	✓					
• Sask. Envir. Society		✓				
• Back to Farm Res. Instit.	✓				✓	
• Sask. Soil Conserv. Assoc.		✓	✓			
• Sustain. Agric. Assoc. Alta.	✓		✓			
• Canadian Fertil. Instit.	✓					
• Dryland Salinity Control Assoc.		✓				
• Nature Conservancy of Canada	✓		✓			

Conversion to Individual Yields

This was a single recommendation but is illustrative of the inter-provincial variation in the nature of how GRIP is administered. In other words, what works in one province may or may not be practised in another. In this instance, the point was made that Ontario's individual historic average yield records (not including the current crop year) are used as the method for calculating program support. This was considered effective in removing concerns over farming of marginal lands because it was in the individual farmer's best interest to maintain productive fields because his/her farm's yields were the basis for determining program support levels.

Provide Incentives to Superior Farmers

Again, although only expressed once, this comment is illustrative of how GRIP, when modified, is perceived to be more responsive to producer's desires to optimize production. In this instance, the point was made that incentives should be available for farmers that maximize production while ensuring that the farming practices are environmentally sustainable.

Provide Incentives to Organic Producers

This comment was received from both organic farmers and representative agencies. There was a perception that GRIP currently does not recognize the benefits of organic farmers as it promotes intensive agriculture, including discouraging crop rotations and encouraging fertilizer and pesticide utilization.

Environmental Cross-Compliance

This was the second most commonly suggested recommendation. Contributors suggested that some form of "contract" should be required to ensure that in return for public monies, farmers do not engage in practices that contribute to environmental degradation or that are contrary to other government programs.

8.2.2 Environmental Cross-Compliance

8.2.2.1 What is Environmental Cross-Compliance?

Use of policy instruments for environmental protection and natural resource management has been increasing throughout the developed world during the past two decades. These instruments fall into three broad categories:

- Information and Awareness
  - extension (technical advice; moral suasion; adoption diffusion)
  - demonstration and pilot projects

> " ... assessing federal and provincial policies and programs to ensure that they are neutral or supportive of environmental sustainability... and ...implementing cross-compliance, by making eligibility for program benefits conditional upon approval of individual farm conservation and waste management plans..." [Page 30]

An example of how environmental cross-compliance might take effect would be specific eligibility criteria for assessing applicants under a particular government program. For example, an applicant would need to file an approved farm conservation plan in order to be eligible to receive government program payments. This approach has been proposed in Alberta and Ontario, has been recently announced as policy in Quebec and is in practice in the United States.

8.2.2.2 GRIP and Cross-Compliance

GRIP has been criticized for failing to satisfy most of the safety net assessment criteria developed by the Grains and Oilseeds Safety Net Committee, including environmental sustainability. Additionally, the revenue insurance component of GRIP is being amber-lighted (subject to scrutiny) under GATT, in contrast to the crop insurance component which is green-lighted (deemed acceptable).

During crafting of the Farm Income Protection Act (FIPA) as well as the Federal-Provincial agreements under which GRIP took effect, there was uncertainty regarding the environmental performance of GRIP and therefore environmental clauses were inserted. These clauses included "...**define the circumstances and conditions under which insurance [program benefits] may be withheld, restricted or enhanced for the purpose of protecting the environment**..." [FIPA section 5 (2) (a)].

The National Agreement Establishing a Tripartite Gross Revenue Insurance Plan (GRIP) for Crops also states:

> "19.2 Within two years of the Agreement coming into effect, Canada and the Provinces agree to complete an environmental assessment report ... on the need for amendments to the Plan, mitigation measures, cross-compliance and environmental regulations as the case may be.
>
> 19.3 Following completion of the environmental assessment report referred to in section 19.2, Canada and the Provinces agree that circumstances and conditions under which insurance may be withheld, restricted or enhanced for the purposes of protecting the environment and of encouraging sound management practices to ensure that environmental sustainability will be established."

This is environmental cross-compliance and this concept is currently not being implemented.

8.2.2.3 The U.S. Experience With Cross-Compliance

As previously described, environmental cross-compliance relating to farm assistance programs in the United States arises from the conservation provisions contained within the 1985 Food Security Act and the Food, Agriculture, Conservation and Trade Act of 1990. There is an abundance of literature which reviews cross-compliance successes and shortcomings (e.g., Cook et al. 1992, Girt 1992, Zinn 1991, Cook and Art 1993, Miranowski and Anderson 1993). Rather than repeating this information here, the reader is directed to the above-described literature.

In an effort to obtain the most current impressions of the U.S. experience with cross-compliance and farm assistance, EMA scientists consulted with key agricultural and environmental agency representatives at meetings in March, 1993 in Kansas City, Missouri (Soil and Water Conservation Society - "The Next Generation of U.S. Agricultural Conservation Policy", March, 1993) and in Washington D.C.. These meetings with over 70 individuals from over 30 agencies were designed to assess the U.S. experience and ascertain what elements of cross-compliance could be potentially applied in a Canadian context. The results of those interviews are summarized below.

What is working now

- Graduated penalties where the landowner is fined in a proportion commensurate with the magnitude of the contravention. This provides some protection from being over-penalized for inadvertent acts of non-compliance.

- Graduated penalties make it easier for Soil Conservation Service (SCS) personnel to report violations, and for Agricultural Stabilization and Conservation Service (ASCS) to impose penalties.

What doesn't work

- Inconsistent evaluations of contraventions because of SCS personnel being concerned about compromising their relationships with landowners with whom they have developed farm conservation plans. The analogy of the SCS having to wear both a black hat and a white hat was consistently cited; this is widely recognized as being a problem.

- SCS personnel are spending far too much time on compliance evaluation work rather than on their original mandate of information extension, that is, developing and helping to deliver conservation planning.

- Compliance evaluations occur only at one time whereas soil erosion problems may occur at various times of year. For example, a compliance inspection might occur only in the spring, whereas soil erosion problems also occur during other seasons.

What could be improved

- Pro-rated penalties for minor infractions after the first contravention rather than losing all farm program monies regardless of the magnitude of the second contravention. This would make the SCS agency personnel and farmer relationship better. However, there is a recognition that habitual offenders must be dealt with harshly.

- Off-farm considerations relating to environmental degradation needs to be addressed, e.g., effects of agricultural runoff on receiving waterbody water quality

Landowner receptiveness

- Little quantitative information on landowner receptiveness to cross-compliance has been collected. One of the few studies in this regard did, however, reveal that on highly erodible land (HEL), approximately 53% of U.S. farmers were complying with conservation plan implementation (Esseks et al. 1993). However, among those farmers with conservation plans, 27% indicated a desire to change those plans and 32% needed clarification on when conservation practices should be applied. A full 47% of the farmers interviewed indicated that they did not intend to comply with conservation compliance initiatives on highly erodible land. A study of Iowa farmers (Padgitt and Lasley 1993) found that farmer support varied with time. Support grew for a short time after conservation compliance legislation was introduced in 1982, reaching a peak of 72%. In 1991, 2 years after implementation, farmer support was near 60%, more than twice the number expressing opposition.

- Cook and Art (1993) revealed that an extremely small fraction of U.S. farms receiving farm assistance benefits were found to be in violation of resource compliance provisions relating to "sodbuster" (HEL violations) and "swampbuster" (wetlands conservation violations). In 1991 for example, the year with the most violations, only 0.05% of the 1.5 million farms that participated in farm assistance programs were penalized for conservation non-compliance. Since 1986, only 2,499 farms have been denied farm benefits because of non-compliance. However, 45% of these farms have had their benefits reinstated. ASCS data revealed that 394 and 156 producers were found in violation of sodbuster and swampbuster provisions, respectively, in 1992 (ASCS, unpublished data). The issue here is not one of apparent widespread acceptance by farmers of the conservation compliance requirements but rather that SCS and ASCS are doing an inadequate job of reporting violations and monitoring compliance (United States Department of

Agriculture 1992). Thus the degree of acceptance of conservation compliance is difficult to gauge.

Administrative/Logistical Considerations

- Creating a new environmental compliance division in USDA would separate enforcement from conservation planning delivery but there would be some duplication of personnel and additional costs. Furthermore, the compliance monitoring personnel would also need to understand the complexities of conservation plans (like the current SCS personnel), not just enforcement issues.

Costs

Discussions with ASCS personnel in Washington, revealed that in 1992, $21 million was spent on activities relating to monitoring of cross-compliance with respect to Highly Erodible Land and wetlands.

8.2.2.4 Considerations for Implementation of Cross-Compliance in Canada

Background

Government interest in the environmental sustainability of farm programs was manifested in the report by the Federal-Provincial Committee on Environmental Sustainability to the agricultural ministers of Canada where a recommendation was made to investigate the feasibility and acceptability of cross-compliance measures in agricultural programs (Agriculture Canada 1990). Indeed, as was described in section 8.2.2.2, legislation relating to the enactment of GRIP requires that program delivery be tied to environmental protection measures (cross-compliance). This interest prompted Agriculture Canada to commission a study to review the feasibility of implementing cross-compliance measures for provincial and federal programs in Canada (Girt 1992).

This interest in cross-compliance has been, to a considerable degree, motivated by an electorate concerned about public monies being allocated to farm support programs with real or perceived environmental liabilities. Esquirol (1991) and various speakers at the Soil and Water Conservation Society Conference in Kansas City in March, 1993 questioned how much longer the non-farm public will accept these expenditures without some sort of accountability in terms of prudent use of our soil, air and water resources.

There is growing evidence that the farming community in Canada is interested in environmental degradation issues. Kreutzwiser and Pietraszo (1986) reported that over 80% of landowners in Ontario recognized the need for wetland protection. Amongst landowners in rural southern Saskatchewan, Young and Thompson (1990) reported that 76% of the population favoured protecting and reclaiming wetlands. Duff (1991) reported that 86% of farmers in an erosion-prone area of Ontario considered soil erosion to be a problem.

Further evidence of this exists in the recent efforts by a coalition of farm organizations in Ontario who formed Ontario's Farm Environmental Agenda to address the maintenance of environmental integrity on Ontario farms. In the County of Stettler in Alberta, a Pilot Study to evaluate implementation of soil and water conservation plans at the Municipal Government level revealed that 53% of farmers acknowledged the occurrence of wind and water erosion (Young et al. 1992). Further, when questioned about their thoughts on the need for conservation programs, 10% indicated there were already too many, 64% indicated there was an adequate number and 26% suggested there were not enough. On the matter of the value of coordinating consistent implementation of soil and water conservation activities, 84% responded that this would be a good idea. With regard to who should administer and deliver such programs, 53% indicated an association of local landowners and local government, 38% indicated the County and Agricultural Service Board, 16% suggested the Province of Alberta and 5%, the Federal Government.

Given the apparent widespread recognition of the seriousness of environmental degradation on the farm, why is the farmer generally reluctant to embrace conservation programs? This really becomes the heart of the discussion regarding the potential acceptability of cross-compliance measures to achieve environmental protection. There are multiple reasons for this. For example, some aspects of soil degradation (e.g., organic matter loss) occur relatively slowly and are not as visible as, for example, weed infestations. Secondly, and perhaps more importantly, soil conservation has few, tangible short-term benefits for the landowner. Put simply, when moisture conditions and commodity prices are good, the landowner perceives few problems. However, when the opposite is true, the landowner is under too much economic duress to adopt sometimes costly conservation practices which do not have immediate economic benefits.

> *"Though a landowner may be cognizant of the societal or external values of wetland habitats, such concerns are usually preempted by his on-farm costs and benefits when the fate of a wetland is being considered. These habitats rarely convey any tangible benefits to the landowner, but instead represent an impediment to increased production and the source of higher operational costs."*
>
> *From: Turner et al. (1987)*
>
> *"Overcoming soil deterioration is one of the greatest challenges that must be met if the future of the Canadian agriculture and food sector is to be assured. The need to succeed in this area is even more important at a time when financial problems cause many farmers to pay less attention to long-range planning. Coordinated action by farmers, public authorities and non-government agencies is therefore required..."*
>
> *From: A National Agricultural Strategy*
> *(Ministers Responsible for Agriculture 1986)*

More fundamentally, conservation measures and conversely, activities such as wetland drainage and cultivation of marginal land incur real or perceived costs and benefits that are not equally allocated between the farmer and the non-farming public.

These costs and benefits are allocated to either society as a whole or to the landowner as an individual. Concerns have been raised that farm-related subsidies, government-sponsored drainage and cultivation of marginal lands are supported by public taxes, with benefits being realized by the landowner. Similarly, the costs of remedial measures such as erosion control and flood prevention structures are generally borne by society and downstream users, and not by the landowner on whose land problems originate (Leitch 1981, Phillips and Veemen 1985, Fuller 1987, Federation of Ontario Naturalists and Environment Canada 1987). Furthermore, these costs are difficult to quantify, unlike the benefits of increased agricultural production (Bardecki n.d., Leitch 1981, Manning et al. 1988), or even increased quota entitlement, both of which directly benefit the landowner.

Conversely, if the farmer chooses to conserve wetland or upland habitat, he/she may forego economic benefits and furthermore, may incur costs such as waterfowl crop depredation. At the same time, society as a whole accrues benefits from the values associated with maintaining that habitat, examples of which include flood protection and recreational opportunities.

The difficulty lies in determining how the cost of supplying benefits can be allocated. If the landowner is expected to manage a valuable resource such as wetlands which produce broad societal benefits, then society will need to consider a means of compensating the landowner for providing those benefits. Similarly, society may justifiably ask that public funds not be spent on activities such as wetland drainage which produces primarily on-farm benefits while compromising a resource which otherwise provides benefits to the public.

Recommendations for Cross-Compliance in Canada

Among other things, the Girt (1992) study revealed that the concept of cross-compliance was being contemplated in Canadian jurisdictions including Prince Edward Island (PEI 1990) and Ontario. Hilts et al. (1989) also reviewed the acceptability of this concept on a National basis. Most recently, Quebec has adopted cross-compliance measures which include the requirement for farm conservation plans to become eligible for farm support monies (Belzile 1993).

Based on the Girt (1992) study, coupled with our evaluation of the U.S. experience and consultations in Canada, the following recommendations for implementation of cross-compliance in Canada are presented.

- As a precursor to environmental cross-compliance establishment, a clear set of environmental objectives needs to be established at both the National, Provincial and/or agroecological levels. For example, targets should be set for: (1) numbers and types of wetlands that need to be protected as part of a broader strategy to conserve and enhance wetlands within the agricultural zone of Canada; 2) maximum nitrate contamination levels of groundwater; 3) maximum rates of soil loss. This follows on the lines of threshold value establishment.

- The semantics or the way that cross-compliance is described influences the palatability of the concept. Cross-compliance need not take the form of regulations for which there is often intense opposition. Examples of this include the U.S. "sodbuster" and "swampbuster" provisions where benefits are denied for not complying with established environmental protection objectives. Rather, they could be more positive or incentive-driven whereby program benefits could, for example, be enhanced in return for environmental protection measures contained in farm conservation plans such as wetland preservation or zerotillage (see section 8.2.3.3).
- Farm conservation plans with clearly defined environmental objectives should be required on a broader basis across Canada. The Provinces of Ontario, Quebec and Alberta are already requiring and/or delivering such programs. These should be more broad-ranging or holistic (referred to in U.S. as total resource management or whole-farm conservation planning) for each farm enrolled in subsidy programs (Bridge 1993). These measures should not be confined to just soil conservation activities on erodible lands but also waste management and avoidance of wetland degradation. Implementation of a policy for conservation plans should be phased in over several years.
- If adoption of cross-compliance on all farms receiving subsidies was impractical, the concept should be introduced for Class IV-VI lands or threatened ecosystems, similar to what is required in the U.S. for Highly Erodible Lands.
- Achieving maximum success in implementing conservation measures will occur when the farmer endorses the concept. However, support in the form of training and technical advice will be required. This should include an extension of existing programs but there must be a recognition that the workload for existing personnel would be substantially increased if all farms are to be incorporated into this exercise. The monitoring component itself will consume considerable time. Establishing an administrative infrastructure to address compliance evaluation would be costly. Furthermore, whether the responsibilities of program delivery and compliance monitoring could be addressed by the same agency must be explored given the existing difficulties in this regard in the U.S.
- A monitoring framework will need to be established to evaluate performance with respect to achieving environmental protection objectives.
- Cross-compliance in relation to GRIP implies a need to evaluate compliance. The data collected for such a purpose will need to be exhaustive to ensure complete

coverage of all program participants. If such was not the case, individual farmers could rightfully challenge the compliance evaluation on the basis that their farm was not properly assessed. Exhaustive areal coverage of all program participants ensures that all program participants be treated equally before the legislation enacting cross-compliance. This suggests that techniques suitable for examining broad areas be applied. This would likely occur through remote sensing, coupled with some ground-truthing.

8.2.3 Administering Insurance Programs to Protect the Environment

As described in section 8.2.2.2, FIPA legislation and the National Agreement establishing GRIP include clauses relating to the conditions under which insurance (GRIP program benefits) may be withheld, restricted or enhanced for the purpose of protecting the environment. This section of the document outlines some examples of how these provisions might be applied to GRIP in order to comply with the wording of the legislation and agreements.

8.2.3.1 Withholding Insurance

For example, insurance could be withheld under any of the following circumstances or conditions:

- failure to develop and then begin implementation of an approved farm conservation plan within specified periods of time after enrolment in GRIP;
- violation, by the applicant, of contractual terms for conservation programs such as the Permanent Cover Program (PCP), the North American Waterfowl Management Plan, whether they be administered by Federal, Provincial, or Municipal governments or private agencies;
- degradation through draining of wetlands, cultivation of grasslands or clearing of woodlands that are designated by Provincial or Federal Governments as being of environmental significance;
- failure to comply with fertilizer application recommendations derived from soil tests and analysis at a registered laboratory;
- upon conviction under any Federal, Provincial or Municipal legislation, regulation or by-law regarding environmental protection (e.g., exceeding manure effluent standards) or resource conservation;
- insurance would be withheld for the year within which the disqualifying activity occurred;

- re-instatement could occur conditional upon the applicant furnishing acceptable evidence of corrective action, compliance with stated laws, and possible restitution for damages incurred.

8.2.3.2 Restricting Insurance

Insurance could be restricted under any of the following circumstances or conditions:

- the applicant applies for insurance for an annual crop grown on Canada Land Inventory (CLI) lands designated as having agricultural capability classes IV, V or VI;
- the applicant applies for insurance for an annual crop grown on lands formerly designated as wetlands;
- the applicant applies for insurance for an annual crop grown on highly erodible soils, regardless of CLI classification for agricultural capability, as determined by local or regional soil conservation authorities;
- the applicant applies for insurance for an annual crop grown on lands designated as being environmentally sensitive (e.g., unique feature), as determined by local or regional conservation authorities;
- **except**, no restriction would apply for the applicant who provides acceptable evidence of implementation of a locally or regionally approved environmental protection plan for such lands.

8.2.3.3 Enhancing Insurance

With this approach, insurance could be enhanced in the form of higher coverage, reduced premiums and/or premium rebates under any of the following circumstances or conditions:

- the applicant files a locally or regionally approved farm conservation plan which includes provisions such as contour plowing, grassed waterways etc.;
- the applicant furnishes proof of implementation of habitat protection or enhancement measures such as retention/creation of wetlands and/or upland habitats such as woodlands or grassland nesting habitat;
- the applicant furnishes proof of habitat protection measures for rare/endangered species;
- the applicant provides evidence of wildlife depredation of farmlands as these lands are clearly providing wildlife habitat;

- the applicant furnishes proof of waste management practices such as manure containment facilities, pesticide storage and handling procedures which contribute to the protection of surface and groundwater quality;

- the applicant furnishes proof of use of recognized but non-conventional or alternative production systems and practices for eligible crops in designated areas, examples of which include:

    - minimum till, no till, zero till, ridge till
    - organic farming according to Provincial or industrial standards
    - enrolment in an integrated pest management and/or fertilizer management program

8.2.4 Alternative Options

The above-described discussion regarding cross-compliance does not represent the only alternative to achieving sustainable agricultural objectives. Other options exist including continuation or expansion of ad hoc programs or outright modifications to the GRIP program.

8.2.4.1 Ad Hoc Measures

Although not an exhaustive list, some of the measures that could be considered include:

- Continuation and expansion of educational programs

- Provide ad hoc incentives for protection of specific environmental resources such as wetlands, rare/endangered species with the intent of communicating that these are assets on the farm rather than liabilities

- Promote multi-agency cooperation such as that under the North American Waterfowl Management Plan - Prairie Care Program to achieve soil conservation and wildlife habitat benefits

- Modify programs such as the Permanent Cover Program (PCP) to further enhance wildlife habitat. For example, the haying or grazing allowed on these lands might have certain conditions attached such as timing and intensity of those activities (e.g., delayed haying, rotational grazing). Additionally, PCP and other programs such as the Land Management Assistance Program could be extended to provide assistance to farmers for shelterbelt and woodlot development.

8.2.4.2 GRIP Program Changes

Two questions must be addressed when considering changes to GRIP: (1) did cropping practices change once a revenue or crop insurance contract was signed; and (2) were the changes, if they occurred, more toward or away from sustainable agricultural objectives. The first question required identifying the base or benchmark from which the change was to be determined. The benchmark was taken as cropping practices followed prior to the contract or farms not signing a GRIP agreement. Analysis of questionnaires completed by farmers indicated that at least three of every four farmers continued to follow comparable cropping practices they had used previously. The predominant change, if it occurred, was of crop selection. Analysis of secondary data concluded that crop selection in the Prairies was influenced more than in the eastern Canadian provinces. All the provinces, with the exception of Quebec, show that the mix of crops produced by farms enrolled in GRIP were less diversified than the group who chose not to belong. Farms unwilling to sign a GRIP agreement produced relatively more feed grains, forages and livestock than the GRIP registrants. Therefore, the first recommendation deals with contractual changes that reinforce market neutrality.

Prior to signing a GRIP agreement, the GRIP members probably depended more upon cereal grains and oilseed crop sales than the group who chose not to enrol. A GRIP contract allowed the more specialized cereal grain and oilseed farms to maintain their income and reduce risk without exploring other options. If the income stabilization contract allowed revenue from all farming sources to qualify, and indemnities were paid when farm income fell below some threshold amount, then the contract would influence enterprise selection to a far lesser degree. Expanding the GRIP concept to include more commodities is basically the approach followed currently in the Farm Income Protection Act. Tripartite red meat agreements, sugar, beans and honey are commodity-based programs. Whether the combined effects of each commodity based stabilization program has resulted in a different agro-ecosystem than a whole farm stabilization program is unknown. It is nearly impossible to design and administer separate commodity-specific stabilization programs so their combined effects are market neutral and environmentally sustainable. Rather than perturbating and integrating an endless number of contractual conditions in the GRIP and Tripartite programs in order to attain market neutrality and environmental sustainability, the Farm Income Protection Act should build upon the foundation in the NISA contract. The survey respondents consistently ranked NISA to have a lesser influence upon their overall farming operation than GRIP or all risk crop insurance.

When policies are developed to simultaneously meet more than one objective (farm income and environmental quality) conflicts can emerge. Rather than add a number of conditional cross-compliance measures to a crop income stabilization program, an alternative approach is to remove a number of the conditions that spell out how a farmer qualifies for support. A qualifying condition, such as seeding one of the eligible crops, tends to lead to less crop diversity and using more inputs. GRIP partially reduces farm income instability because only some crops qualify. Farm income stability can also be reduced through diversifying revenue

- Economic Instruments
  - fiscal incentives (grants, loans, contracts, reduced premiums)
  - product charges (special taxes on phosphate detergents, gas tax)
  - emission charges (fines for pollution)
  - tradable emission rights
  - land use zoning

- Direct Regulation
  - legislation (Canadian Environmental Protection Act)
  - standards and regulations (effluent release, drinking water standards)
  - municipal by-laws (landfill by-laws)
  - land use zoning (no development in floodplains)

Cross-compliance is a policy instrument with features common to the latter two categories. Cross-compliance has been defined as "**an expression denoting incentive or disincentive measures which are used to affect compliance, or harmony, between two or more policies or programs**" (Report of the Federal-Provincial Agricultural Committee on Environmental Sustainability, June 30, 1990).

Environmental or conservation cross-compliance is practised in other jurisdictions, most notably in the United States, Europe and Australia (Cohen et al. 1991, Girt 1992). In the United States, it became prominent with the introduction of the 1985 Farm Bill under which "conservation compliance for highly erodible land", "sodbuster" and "swampbuster" became prominent terms in the lexicon of agro-environmental affairs.

The concept of environmental cross-compliance is not a new one in Canada for that matter. In 1989, Agriculture Canada articulated a vision for Canada's agriculture and food sector, in a discussion paper entitled " Growing Together: A Vision for Canada's Agri-food Sector". That document provided a conceptual framework within which to organize the most comprehensive review of Canadian agri-food policy ever undertaken. Environmental sustainability figured prominently in the ensuing Agri-food Policy Review (APR), especially through the work of the Federal-Provincial Agricultural Committee on Environmental Sustainability.

The "Growing Together" document of 1989 included the following statement as part of its principles for action:

> "All government programs and policies must take into account environmental sustainability in their design and delivery. Compliance with environmental requirements may have to be encouraged." [Page 69]

Subsequent to that document, the "Report to Ministers of Agriculture, Federal- Provincial Agriculture Committee on Environmental Sustainability, June 30, 1990" included recommendations on policy and program reform which included:

TABLE 8.3

SUMMARY OF THE IMPACTS OF THE 1992 GRIP PROGRAM ON FARMING PRACTICES AND LAND USE DECISIONS

ISSUE	B.C.	ALTA.	SASK.	MAN.	ONT.	P.E.I.	N.S.	N.B.	CANADA
Cropping/Land Use Diversity	-MiS*	-MiS	-MiS	-MiS	-MiS	-MiS	-MiS	-MiS	-MiS
Soil Erosion	+ MiS	+MiS	+MiS	+MiS	+MiS	+MiS	+MiS	+MiS	+MiS
Water Quality	+NS	+NS	+NS	+NS	+NS	+NS	0	+NS	+NS
Habitat (Wetlands)	-MiL	-MiL	-NL	-MiL	-MiL	-MiL	0	-MiL	-MiL
Habitat (Upland)	-NL	-NL	0	0	0	0	0	0	0
Air Quality	+NS	+NS	+NS	+NS	+NS	+NS	0	+NS	+NS
Cumulative	-MiL	-MiL	+NS	-MiL	-MiL	-MiL	0	+NS	-MiL

*Impact Direction, Magnitude and Duration, where:

Direction: + (Positive), - (Negative), 0 (Neutral)
Magnitude: N (Negligible), Mi (Minor), Mo (Moderate), Ma (Major)
Duration: S (Short-term - < 10 years), L (Long-term - > 10 years and/or several generations)

HAS GRIP AFFECTED WATER QUALITY?

Water quality can be affected by introduction of nutrients and other farm products into receiving waterbodies. The effect of GRIP on water quality was measured by evaluating inputs of fertilizers and pesticides, land use practices, and EPIC simulations to measure the likelihood of non-point source pollution.

GRIP had no appreciable impact on the use of chemicals and thus impacts on water quality from this perspective were unlikely. As described in the soil erosion discussion, farming practices under the GRIP regime should actually lead to reduced erosion and improved water quality; but these improvements would be difficult to detect on a broad geographic basis. EPIC simulations confirmed no existing or projected increases in non-point source pollution. Thus, it was concluded that **water quality under GRIP had a positive, negligible, short-term impact.** Again, we considered the impact short-term because a changing market could result in changing land use and input use practices.

HAS GRIP AFFECTED WILDLIFE HABITAT INCLUDING WETLANDS?

Farming activities have the potential to decrease wildlife habitats through wetland drainage or cultivation of grassland habitats or conversely, to increase them through conservation-tillage or planting of forage crops. The impacts of GRIP on wildlife habitats were assessed in terms of wetland and upland habitats, based primarily on surveys of farmers and indirectly through measures in land use practices.

As far as wetland habitats are concerned, a relatively large proportion of survey respondents (17%) indicated that they had drained wetlands between 1990 and 1992, although the proportion of farmers that attributed this drainage to GRIP was small (less than 5% of respondents). This provides strong evidence that wetland drainage continued through 1991 and 1992 on a large scale and that GRIP apparently exacerbated the problem. While the number or surface area of wetland basins adversely affected by GRIP was likely to have been small, the cumulative effect of continual drainage under the program is likely to be larger with time. Wetland margins also contribute to the overall functional capability of wetlands and there was evidence that these were also adversely affected by GRIP. Again, however, the proportion of farmers attributing this to GRIP was small (less than 2%). Notwithstanding, the cumulative effect of continual wetland margin degradation under the program is likely to be larger with time.

Wetland creation programs do exist in Canada and while they add to Canada's inventory of wetlands, this is occurring independent of GRIP. Thus, given Canada's dwindling wetland resource, Canada's position on "no net loss of wetland function", the vulnerability of continental waterfowl populations which rely upon wetlands and their margins, and the stated objectives of the North American Waterfowl Management Plan to increase wetland habitats and waterfowl populations, **the degradation of Canada's wetland resource because of GRIP was concluded to be a negative minor impact in the short-term, but could lead to** sources, self-insurance, forward contracts and management with timely information. A whole farm approach to income stabilization rather than a commodity-specific program encourages farmers to seed some of these other stabilization options prior to relying upon safety-net financing. NISA has many of these attributes if the contributions to, and limits on the size of the NISA stabilization accounts, need to increase before farmers will perceive it as a risk management option.

The second recommendation addresses market neutral stabilization programs and farming practises undertaken independent of income stabilization contracts. If an enhanced NISA program replaced GRIP and an environmental assessment determined some farming practises reduced environmental quality and ecosystem stability, the most appropriate course of action may not be conditional clauses in a NISA/GRIP agreement. Instead, the sustainability issue is likely to be regional because of the unique characteristics in each agro-ecosystem. Issues of this nature are better dealt with through such measures as: licensing of chemicals, restrictions on land use with certain soil/water characteristics, the preservation of unique environments and implementing specific waste management regulations for the circumstances identified.

8.2.4.3 Land Set-Aside

Ducks Unlimited Canada (1992) proposed that impacts of GRIP related to land use on marginal lands could be mitigated through a land set-aside system. Crop insurance has difficulty in providing insurance to farmers for cropping low productivity lands. The proposed land set-aside system would incorporate "green certificates" that would draw annual payments for marginal lands converted from grains to permanent grass cover. These certificates would be offered to farmers whose costs of production on marginal lands cannot be covered actuarially from long term production from these low productivity lands. Such an approach would be less expensive than current subsidies (estimated public treasury expenditures reduced by three dollars for every dollar committed to green certificates), would be more sustainable environmentally and may be considered non-distorting under the Dunkell rules of GATT.

8.2.5 Residual Impacts

Residual impacts are those environmental impacts that persist despite the implementation of mitigation measures. The mitigation of GRIP-related environmental impacts through the implementation of cross-compliance will not restore land taken out of pasture or permanent cover. Also, wetland and riparian areas degraded before the implementation of cross-compliance will not necessarily be reconstructed.

However, soil productivity losses and increases in NPSP should not necessarily be residual. Well managed agro-ecosystems need not contribute more to these negative environmental impacts than natural ecosystems. The residual impact on soil productivity can only be assessed properly in the long-term or through long-term simulations. This is further justification for the on-going environmental monitoring of GRIP.

8.2.6 Environmental Monitoring Programs

8.2.6.1 Introduction

The environmental monitoring program for GRIP should be aimed at gathering data capable of yielding useful indicators, criteria and thresholds of environmental sustainability. To ensure cost-effective areal coverage of all GRIP-influenced areas, we recommend the use of archived and immediate remote sensing imagery. The cost-effectiveness of such imagery, be it Landsat Thematic Mapping (TM) or SPOT (Satellite Pour l'Observation de la Terre), is highly dependant on the size of the areal coverage; remotely sensed data for small areas is not cost effective. Over large tracts of land, remote sensing is by far more cost-effective than aerial photography, let alone farm-by-farm field inspection. Monitoring would most likely involve sub-sampling of broad agroecological areas rather than the entire area within which GRIP is administered.

Data gathered for monitoring, modelling and analysis of GRIP-induced land use changes and its long-term environmental impacts could also be used for compliance evaluation. However, as environmental monitoring and analysis only requires statistically representative samples rather than an exhaustive areal coverage, data gathered as part of the cross-compliance evaluation effort would need to be more comprehensive to incorporate all GRIP participants.

It is important to note that the monitoring of GRIP using information derived from remotely sensed TM and SPOT data is not contingent upon the evaluation of cross-compliance. If cross-compliance was deemed too controversial or beyond the budgetary limits of FIPA, monitoring alone, because it is less data intensive, would also be less expensive.

8.2.6.2 Land Use

Julian Dumanski and Margaret Cann from Agriculture Canada's Centre for Land and Biological Resources Research (CLBRR) have proposed a number of land use parameters as indices of environmental sustainability, including the following.

- Cropping intensity (%): The ratio of land cropped in any one year on the average, to that of physical area in agricultural use.
- Arable land as a percent of total land: An indicator which would show the resource availability of arable land.
- Irrigated land as a percent of arable land: An indicator which would show the resource availability of irrigation as a percent of arable land.

- Growth of gross agricultural production (% per year): When juxtaposed with self-sufficiency ratio the question "*is agricultural production keeping up with the population growth rate*?" is addressed.

- Self-sufficiency ratio (%): This ratio indicates, according to the total agricultural production, whether a country could theoretically support its population without importing.

- Net primary production: This indicator is used as a basis for evaluation the biological performance of a landscape.

- Per capita grain and food production (t per persons): The trend in per capita grain production gives a sense of whether overall food availability is improving or deteriorating.

- Maximum sustainable yield (t per hectare): A variant of the Carrying Capacity model which is designed to prevent the maximum sustainable yield of a given renewable natural resource from being exceeded.

- Cereal production trend: When there is an overall decline in cereal production, it is an indication of a possible food crisis. (This is probably more applicable to Africa than to countries like Canada which export grain).

- Fertilizer and pesticide use and nonpoint source pollution risk: Because of the loss of nutrients and chemicals through surface runoff and leaching beyond the rooting zone, their use can be used as an indicator of NPSP risk.

- Crop yield and soil productivity trends: Long-term crop yield estimates, once adjusted for increased or decreased inputs, are a necessary measure of the inherent soil productivity. Accelerated rates of soil productivity loss are an indication of potentially irreversible soil degradation.

This list relates primarily to land use and input use, and does not include either discipline-specific environmental indicators or threshold values for these disciplines. A more comprehensive discussion in that regard is thus presented below.

8.2.6.3 Soil Degradation and Non-Point Source Pollution

The environmental monitoring program for GRIP should be focused toward collecting quantitative data which can be used to assess change. The survey that was completed as a component of this study is indicative of the kind of information that is required from a monitoring program. It is likely not possible to find a single measurable parameter that can be used to evaluate environmental sustainability. Instead monitoring should focus on collecting accurate and relevant biological, physical and chemical data along with land use practice information so that the information can be used to track changes in calculated indicators. The indicators are not measurable parameters such as soil erosion but calculated parameters based upon linkage models such as EPIC or simple ratios. What is imperative before any monitoring plan is developed is that the indicators, criteria and thresholds which are intended to be used to evaluate environmental sustainability be developed first.

Experience gained from this evaluation suggests that models like EPIC are very good integrators of information that can produce relevant information to use as indicators. However, the models are only as good as the information they use and a significant component of any GRIP monitoring program should include monitoring of parameters which drive EPIC and/or other environmental models.

8.2.6.4 Wildlife Habitat Changes

The impacts of GRIP on wildlife habitat need to be monitored for both terrestrial and aquatic (primarily wetland) habitat. As previously described, we had established a zero tolerance threshold for wetland loss in conformance of stated Government of Canada policy (Government of Canada 1991a). Adopting this approach, monitoring of wetland degradation to determine exceedance of this threshold could be a relatively simple task involving only the demonstration that a single wetland had been affected.

In practical terms, it will be important to understand the magnitude of GRIP-related wetland impacts not only in terms of numbers and surface areas of wetlands affected but also the nature of those impacts (i.e., wetland basins or margins). As a precursor to this, however, a wetland data base is required.

Wetlands in portions of Canada (particularly the Prairie Provinces) are currently being documented using satellite imagery (primarily by Ducks Unlimited Canada) and limited ground-truthing. Satellite technology allows for broad areas to be surveyed but the degree of resolution is insufficient to identify small wetlands. Other imagery such as False Colour Infra-Red photography provides good resolution but is more expensive. Ground-based surveys also provide good detail but they are labour intensive and impractical for surveying large areas.

The Canadian Wildlife Service in conjunction with the U.S. Fish and Wildlife Service have, since 1955, annually monitored wetland abundance along a standardized series of transects within selected portions of Canada as part of waterfowl inventory studies. This provides an excellent data base for describing long-term trends in wetland occurrence. It does not, however, provide an overall inventory of Canada's wetlands.

The Canadian Wildlife Service also monitors impacts on wetland basins and margins, again, by sub-sampling along pre-selected transects throughout portions of rural Canada (Turner et al. 1987). While this approach provides valuable information, it does not sample a very large area. Furthermore, by focusing on seasonally flooded, semi-permanent and permanent

- Limitations in our ability to acquire primary data on farmer land use behaviour because of privacy considerations.

- Inaccuracies inherent to the soil layer information obtained from the National Soil Data Base. The SLF was developed independently by provincial soil survey units of CLBRR. Inconsistencies between these units has yet to be resolved. These inconsistencies led to some inaccuracies.

- Delay in the obtaining of secondary information from provincial crop insurance agencies. This prevented us from acquiring recent yield (Mg ha^{-1}) necessary for the calculation of LER and GMA as indices of crop species diversity. Yield data was not a required primary or secondary data. Time constraints prevented us from acquiring it for the sake of LER and GMA calculations.

- Inaccuracies inherent to econometric and biophysical models. This is especially true of the EPIC model when applied at the reporting area level rather than at the field level for which it was initially designed,

- Limited period of effective GRIP program (one year). Econometric and biophysical information aggregated at reporting area level is unlikely to reflect minor changes in land use and environmental impacts after such a short period. Moreover, many producers might wait until they fully understand the new programs before they change their land use or input use practices.

8.2.7.2 Further Characterization of Farmer Attitudes and Characteristics

Despite a rather comprehensive survey of Canadian farmers during this study, additional analysis of farm characteristics and attitudes would be useful. Miranowski and Anderson (1993) concluded that farm characteristics need to be better understood in order to design and implement effective conservation and environmental policies. Such information would improve program delivery efficiency by targeting problem areas and allocating incentives to farms to ensure maximum cost-effectiveness for expenditures of public monies. For example, Miranowski and Anderson (op. cit.) found that farmers operating large farms represented a substantial proportion of the total farmland in the U.S. and also displayed a high rate of participation in farm programs. With finite public monies available for farm support programs, it would make sense to focus monies on these operations as they would yield higher conservation benefits. However, in the absence of more detailed information on characteristics of these farms, policies relating to environmental sustainability will be much less focused.

8.2.7.3 Land use and Soil Productivity and NPSP Risk

The assessment of the impact of land use changes on soil productivity and NPSP risk is deficient to the extent in that it is not sufficiently integrated at the regional (reporting area) level. This greater integration involves the integration soil and hydro(geo)logic processes as well as the integration of GIS, Image Analysis Systems and biophysical modelling. For instance, the integration on a watershed basis of soil based (SWRRB), nonpoint source pollution based (AGNPS, ANSWERS) and wildlife habitat based (HEP) merits consideration for future study. To a large extent this integration approach to the assessment of land use's environmental impact on soil productivity and NPSP is an adaptation of the USEPA's work, especially in Wisconsin (Buchan et al. 1991; USEPA 1993; Buchan et al. 1992).

The main information deficiencies pertain to the change in the areal extent of prevalent land use scenario, and to the accuracy of the soils and topographic data necessary to perform legitimate simulations of the environmental impacts of this change. The data extensively collected as part of the cross-compliance evaluation effort could very effectively supplement, if not supplant surveys and other means of opinion polling. Remote sensing necessary for this data collection could also serve to improve the topographic parameters used by EPIC. The accuracy of the soils information used by EPIC is largely the responsibility of the developers of the Soil Layer File, that is CLBRR.

There is an inherent limitation to the estimation of environmental impacts using the product of the change of the areal extent in prevalent land use scenario and the EPIC generated long-term soil productivity and NPSP risk indicators. The EPIC generated long-term average for a given land use scenario is not necessarily proportional to the long-term environmental impact of this scenario. A gradual yield decrease over time and an accelerated yield decrease preceded by little or no change could lead to similar long-term average yield values. However, an accelerated yield decrease is a sure indication that irreversible soil degradation has occurred and that the sustainability of the agroecosystem is threatened, whereas a more gradual decrease is an indication that the agroecosystem is to some extent buffering change and that soil degradation is still reversible.

The exhaustive analysis of the EPIC-generated responses of soil productivity and NPSP risk over time could allow us to determine a more suitable index of agricultural sustainability than the long-term average. Such an analysis was attempted by EMA. It was based on an attempt to quantify the gradual and catastrophic soil productivity and NPSP risk trends. The resulting values could then replace the long-term averages presently multiplied by the surveyed changes in areal extent of prevalent land use scenarios. The resulting estimate would be more indicative of the impact of land use changes attributable to GRIP and NISA on environmental sustainability than the present estimates based on long-term averages.

EMA's attempt at such an exhaustive analysis of the impacts on environmental sustainability of the land use changes attributable to GRIP and NISA was limited by the following.

1. The inherent inaccuracies of EPIC when applied on an areal extent beyond the field or quarter section. Though we have qualified the appearance of the soil productivity and NPSP responses and the long-term averages we have obtained, these EPIC outputs may not justify an exhaustive analysis. We

would have to at first verify that the occurrence of thresholds and gradual trends is in fact an inherent quality of the agroecosystem rather than an artifact of EPIC when applied at the regional level.

2. The inherent inaccuracies of the Soil Layer File (SLF) developed by the Centre for Land and Biological Resource Research (CLBRR). The accurate description of the soil profile's horizons is the single most important EPIC requirement. The SLF's chemical and physical description of soil horizons is presently unstandardized and inaccurate in many respects. Many of the EPIC parameters had to be generated by EPIC itself which increases the incidence of idiosyncrasies and artifacts.

3. The tedious aspect of trend and threshold analysis. Unexpectedly, the analysis of the simulated long-term responses of soil productivity and agricultural NPSP risk required much more than the determination of linear regression coefficients and the identification of discrete thresholds. Most of the responses deemed linear were very gradual and thus had very small regression coefficients with large errors associated to them. Discrete thresholds rarely occurred or did so haphazardly or were difficult to rationalize agronomically.

8.2.7.4 Wildlife Habitat

The primary wildlife habitat information deficiencies relate to the absence of a comprehensive data base on wetland distribution and abundance. With these data in hand, examples of some key questions that should be posed and researched include:

- What habitat information is required to model the effects of broad landscape changes on wildlife populations? As described earlier, it is clear that detailed inventories of wetland numbers, types and distribution represent some of the obvious data requirements. Similarly, from a terrestrial habitat perspective, the location and amount of riparian, grassland and woodland habitats needs to be documented. However, there may be much more detailed information required, such as vegetation species composition and vegetation structure (e.g., density and height) to model habitat capability and sensitivity to change.

- Documentation of the numbers and surface areas of wetlands, and surface areas of upland habitats affected by GRIP.

- What farming-related changes in habitat features will trigger habitat degradation?

- What are thresholds for various habitats beyond which species sustainability is jeopardized?

- What are the cumulative impacts of habitat loss on species that are dependent upon these various habitats?

- What differences in bio-diversity exist under various land use practices?

8.2.7.5 Other Issues

As mentioned earlier, more information on air quality, surface water quality and fisheries would be desirable for a more comprehensive environmental assessment of GRIP-related impacts. These data could be collected through a combination of farmer surveys as well as secondary information arising from other research endeavours. In particular, these could include:

Air

- documentation of the atmospheric effects of different land uses. For example, do grassland areas act as a carbon sink relative to cultivated areas?

- documentation of what increments in farm machinery utilization could lead to measurable increases in air emissions?

- documentation of the magnitude of different land use practice contributions to air pollution in the form of blowing dust. For example, how much more wind-borne dust emanates from summerfallow fields versus zerotill fields?

Water Quality

- documentation of the effects of pesticide and fertilizer inputs on nonpoint source pollution in densely inhabited areas such as southern Ontario versus less densely inhabited areas such as the Prairie Provinces.

- Watershed scale modelling of the aquatic concentrations resulting from predicted non-point sources runoff.

Fisheries

- documentation of the effects of riparian habitat removal on fisheries resources.

- documentation of the effects of nonpoint source pollution on fisheries resources.

- future environmental assessments of GRIP/NISA should include estimates of LER, GMA and the agronomic and phytopathological benefits of increased intro-specific genetic diversity. These agronomic parameters are more likely to yield conclusive data than ecological measurements of biological and species diversity ill-adopted to agroecosystems.

8.3 SUMMARY

This chapter has focused on the extent to which GRIP has influenced agro-ecosystems specifically, and the environment in general. It must be emphasized that the conclusions drawn from this assessment are based on a short evaluation period. Moreover, because the program was new, it is likely that many producers did not want to change their farming practices until they fully understood the program and/or until they were convinced the program would continue in the years ahead. Because FIPA requires that programs undergo environmental reviews every five years after the initial assessment, there will be opportunities in the future for better assessments of the longer-term effects of GRIP.

It is important to re-state that the scope of this environmental assessment was confined to the period immediately preceding the introduction of GRIP and the first two years of GRIP's operation. It was intended to measure the incremental changes in environmental performance because of GRIP. It was not an evaluation of the implications of farm support systems versus no farm support systems. This was the case because Canada has a long-standing history of farm support systems such as crop insurance, WGSA and various ad hoc programs dating back over 30 years.

It needs to be emphasized that GRIP introduces a time lag buffer between changes in market conditions and the farm level response to those changed conditions. GRIP does not prevent those market influences from eventually altering farmers' decisions regarding what to produce and how to manage production. The potential impact of GRIP on the environment is much less than the potential impact of the market itself. Indeed, we would argue that high grain prices (and zero or negative payouts under GRIP) would bring more marginal land into production, cause more wetlands to be drained or degraded, and generally result in much greater environmental effects than could ever be attributed to GRIP alone. Historically, that was what happened during the 1970's when grain prices were high and stabilization payments were very low. The environmental consequences of those market-driven farming decisions led directly to urgent calls for soil conservation and wetlands protection.

In the future, when the sector emerges from a protracted period of low prices and high GRIP payouts and the GRIP account is in a deficit position, GRIP may actually operate in the reverse manner, by off-setting the market incentives to expand (because premiums would greatly exceed payouts, thus reducing net returns). Consequently, in our view, the potential environmental damage linked to GRIP might be insignificant when compared to the potential damage induced by a completely freely operating market, in the absence of restrictions governing land use, drainage, cultivation of marginal lands and other elements of an effective conservation compliance policy.

A summary of the impacts of GRIP at the Provincial and National level for the primary measures of environmental performance is presented in Table 8.3.

HAS GRIP AFFECTED CROPPING AND LAND USE DIVERSITY?

Crop and land use diversity is considered to be important because a more diverse crop mixture should help insulate farmers from the vagaries associated with adverse growing and market conditions. Additionally, greater land use diversity is considered valuable because of the variety of environments available to Canada's flora and fauna.

Statistical analyses of primary and secondary data revealed that farmers participating in GRIP tended to have more specialized farms, with cropping emphasis placed on wheat, corn, oilseeds and pulse crops. Less specialized farms, particularly those with livestock and feed grain operations tended not to enrol in GRIP. Therefore, under GRIP, already specialized farms remained so or became slightly more specialized because of crop revenue guarantees.

A companion analysis of land use diversity based on Canada Census data and the farmer surveys revealed that overall land use diversity did not decrease during the period of assessment. However, because this analysis could not control for GRIP (i.e., could not directly verify the program's influence on land use diversity), we placed more weight on the findings of our statistical modelling. **Thus, we concluded that the overall impact of GRIP on cropping and land use diversity was a negative, minor, short-term impact.** We considered it a short-term impact because a changing market will influence cropping diversity.

HAS GRIP AFFECTED SOIL EROSION AND NON-POINT SOURCE POLLUTION?

Accelerated soil erosion arises when soils are exposed to the influences of wind or water. This erosion removes topsoil and can decrease soil productivity and increase non-point source pollution through the introduction of nutrients, fertilizers and pesticides into receiving waterbodies.

Based on evidence of more conservation tillage, less summerfallow and more forage crops, there was compelling evidence that GRIP could be considered in its first years of operation to have had **a positive, minor, short-term impact in terms of reduced potential for soil erosion and non-point source pollution**. The degree to which this will hold true for the longer-term is less certain because land use practices might change with a changing market. Nonetheless, EPIC simulations suggested that existing farming practices will result in sustained soil productivity for the foreseeable future.

wetlands, other wetlands, notably ephemeral or temporary ones are not examined. These latter wetlands are important not only for wildlife but for a host of other wetland functions. Additionally, due to their small size and shallowness, they are also more susceptible to agricultural-related impacts.

Given the broad geographical area to be addressed, some form of remote sensing must be used. Satellite imagery holds promise but a greater level of resolution (5 m x 5 m pixels versus current 30 m x 30 m) than is currently available would be desirable. The United States has a National Wetland Inventory Program where False Colour Infra-Red aerial photography (scale of 1:48,000) is used to monitor "swampbuster" compliance. This scale of photography allows even the smallest of temporary wetlands to be identified. Additionally, this approach would be suitable for monitoring critical upland habitats. However, while it is comprehensive, it is also expensive. A role also exists for ground-truthing, particularly where uncertainty about impacts due to human influences versus climate exists.

It would appear that a combination of techniques could be used. Satellite imagery could be used to monitor overall trends in larger wetlands and upland landscapes on a regular, but infrequent basis. More detailed False Colour Infra-Red aerial photography could be obtained in representative agroecological areas more frequently to monitor impacts to wetlands and critical upland habitats. Convenient sized areas for this approach tend to be 3.2 km x 3.2 km blocks. With time, all of the agricultural zone of Canada should be inventoried in this manner. Selected blocks could be chosen for long-term monitoring purposes. If compliance evaluation becomes an issue, then these blocks could be randomly selected on an annual basis for inspection.

8.2.6.5 Surface Water Quality

In this evaluation of GRIP, environmental impacts to surface water quality were limited to changes in non-point source loading. There was no consideration of the surface waterbody that drained the agricultural area, nor any consideration of where that waterbody ultimately flows. The impact of non-point source loadings on surface water quality is both a function of the amount of nitrogen, phosphorus and sediment being generated and the capability of the water body to assimilate the material. For example, large fast flowing rivers may not be as impacted by non-point source runoff as shallow lakes.

A component of assimilative capability is also existing water quality conditions. Some waterbodies already have more nutrients or sediments than they can assimilate and ecological utilization of that water body may already be impaired.

Surface water quality monitoring is conducted on a national scale by Environment Canada through both the Water Quality Branch and through the Water Resources Branch. The Water Resources Branch only collects information with respect to sediment transport and accumulation whereas Water Quality Branch monitors all of the various chemical parameters from nitrogen and phosphorus through pesticides and priority pollutants. The Federal agencies tend to have monitoring locations at provincial and international boundaries and in the National Parks.

Provincial agencies and in some cases local authorities also monitor water quality usually at more locations but generally with less rigor as the monitoring is usually issue specific versus baseline monitoring.

On a watershed basis, phosphorus, nitrogen and sediments can be monitored to determine effects due to land use changes. In fact there likely exists a wealth of water quality data at numerous locations which can, and indeed may have already been analyzed to detect trends with time. This type of monitoring and analysis does not monitor change at the farm level but the cumulative effects of all changes in the basin. In watersheds which are entirely agricultural, interpretation of the results are more straight forward. However, in mixed function watersheds, sources of nitrogen, phosphorus and sediments other than agricultural must be subtracted. A significant non-agricultural source of these parameters are industrial and municipal point source discharges. These are however monitored intensely and can therefore be accounted for.

Water quality monitoring at the outlet of watersheds is a valid monitoring approach for assessing change. While many of the water quality monitoring programs already exist, they should be reviewed with respect to providing the specific requirements of evaluating agricultural non point source runoff effects.

Trace organic chemicals like pesticides and herbicides are difficult to monitor in the aquatic environment because they usually occur in concentrations below analytical detection limits. Being below an analytical detection limit does not necessarily mean that they do not have any ecological effects. An effective method of monitoring for trace organic chemicals is through benthic invertebrates. Benthic invertebrates inhabit the bottom sediments in all natural waterbodies. They are relatively non-mobile and are effected by long-term exposure of trace contaminant levels through bioaccumulation and lethality. Benthic invertebrates have a broad range of susceptibilities to contaminants and have been used as biomonitors for so long that there is a wealth of information on what species are sensitive to which types of contaminants. Their long history as biomonitors also provide information to assess past as well as future trends. Benthic invertebrate monitoring is presently a common biomonitoring tool below point source discharges.

8.2.7 Information Deficiencies/Future Study Needs

8.2.7.1 Introduction

This study represents the first environmental assessment of Canada's farm programs. However, many aspects of the present environmental assessment were limited by information deficiencies. These include:

a negative moderate/major impact in the long-term because of incremental wetland losses. The rationale for long-term impacts relates to the fact that once wetland basins are destroyed, they have lost their long-term functional values. Given this adverse impact, mitigation measures are recommended. For example, Canada should give consideration to approaches to wetland conservation such as "swampbuster" which has been implemented for U.S. farm programs. These measures coupled with incentives could lead to a net gain in Canada's wetland resources.

For upland habitats, GRIP evidently did not adversely affect grassland or woodland areas in terms of converting them to cultivated lands. Indeed, there was an increase in forage crop acreage which would be beneficial to wildlife. Similarly, the reduction in summerfallow acreage and the adoption of more conservation tillage practices would also be advantageous to wildlife. There was, however, a GRIP-related influence on farmers to reduce the width of their field margins and also riparian habitat zones. Again, the proportion of farmers influenced in this regard was small and largely confined to the Prairie Provinces. Thus, on balance, despite some declines in upland habitat, there were compensatory increases through changing land use practices that would suggest that for Canada as a whole, **the impact of GRIP on upland habitat was neutral.** This conclusion is not intended to suggest that the identified degradation of upland habitats is acceptable. Rather, we would recommend that mitigation in the form of cross-compliance measures such as "sodbuster" be considered to slow or halt further loss of these habitats. By invoking such measures, coupled with incentives to encourage the identified gains associated with conservation tillage, reduced summerfallow and more forages, we could begin to see an accrual, rather than loss of wildlife habitat, similar to what is occurring in the U.S. (Young and Osborn 1990).

HAS GRIP AFFECTED AIR QUALITY?

Air quality could be affected by dust arising from soils exposed to wind erosion or through greenhouse gases such as carbon dioxide being released from cultivated lands.

As described above, soil erosion has been reduced under GRIP, which should result in improved air quality through a reduction in wind borne dust. The increase in conservation farming practices and increased forage acreage could also contribute to reduction in carbon dioxide which would otherwise be emitted from summerfallow lands. It would, however, be difficult to detect these improvements in air quality and **thus, GRIP was considered to have positive, negligible, short-term impacts on air quality.** As with water quality, a changing market could result in changing land use and input use practices; hence the designation as a short-term impact.

OVERALL ENVIRONMENTAL IMPLICATIONS OF GRIP

When all the environmental performance measures were considered, it was determined that the impacts of GRIP were both positive and negative, and in some instances neutral. In no instance, however, were those impacts determined to be more than minor in nature, on an impact evaluation scale ranging from negligible through minor, moderate to major.

Based on an evaluation of the first 2 years of GRIP, GRIP's cumulative impact was considered to have been negative and minor; a conclusion triggered by the degradation of wetlands. This degradation, albeit small in scale, was considered to be sufficiently important because of stated Canadian policies for wetland protection, to supersede the several positive impacts of GRIP.

A further evaluation of GRIP's implications to wetlands and other environmental issues will be the focus of the next environmental assessment after 5 years of GRIP.

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